BOMBAY COTTON

AND

INDIAN RAILWAYS.

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BY

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"Nothing shows in a more striking manner how blind the cleverest Natives sometimes are to their best interests, and how much in all ages a peculiar genius, and an ardent zeal, are required to rouse the multitude from their indifference to new things; to make them see clearly what is before their eyes, and to give them energy to turn their labour and dexterity to account."

Dr. Ure *On the Cotton Manufacture of Great Britain.*

"Sera nunquam est ad bonos mores via."

"It is never too late to mend your *ways*."

Eton Grammar, free translation.

LONDON:

LONGMAN, BROWN, GREEN AND LONGMAN,

PATERNOSTER ROW.

1850.

LONDON:
Printed by S. & J. Bentley and Henry Fley,
Bangor House, Shoe Lane.

PREFACE

In writing this small Essay, the author has had this difficulty to contend with, viz., the necessity in treating of the introduction of an English system of Locomotion into India, of addressing both the English and the Indian reader, pointing out to one the great modifications required to render a system of Steam Locomotion suitable to India; and to the other, the nature of this system, the manner of its first introduction into England, the errors believed to have been committed on some points, and the wonders generally achieved in perfecting *this*, to a native of India, extraordinary triumph of Art and Science over Nature; by which the writer has been compelled to dwell upon some points already too well known in India to require any comment, and upon others familiar as household words to the English reader; he has therefore to crave indulgence from both parties for such portions as may appear to either useless repetitions of acknowledged truths and facts.

The introduction of a system of Internal Communication so totally opposed to the present habits of a people, is of too serious and important a character to be lightly considered. The express object and intention of the Railway Company is to monopolise the *whole*

traffic of the country on all the leading lines of thoroughfare, thus annihilating at a blow the whole of the present system of transit on these lines; to force upon the inhabitants of a country, whether they like it or not, a totally new and, to them, incomprehensible system of conveyance, for without a *monopoly* of transit the Railways cannot pay; it is therefore useless to argue that the natives will still be left a *choice* of the means of conveyance for their goods, produce, &c., when Railways in which a paramount government have a direct interest are once established on their land.

In introducing, therefore, such an innovation as, we justly believe, must and will prove the greatest eventual blessing that could be conferred upon the country, care should be taken, so to make our arrangements, that the present habits and prejudices of the people should be as little interfered with as possible; and that the new means of conveyance thus provided for them should be adapted to the particular requirements of the districts into which it is introduced, in order that the natives of India may be led to enter willingly into the scheme, and not be called upon to submit to what they might consider an unjust and tyrannical measure ; it is, therefore, with the hope of placing this view of the subject clearly before the Public and the Government, and of freely and fairly examining both sides of the question, so as to divest it of all purely party feeling and interested motives, that the following pages have been written.

The first chapter of this Essay is devoted to a slight review of the present state of our Cotton Trade and of the effects the construction of the proposed Bombay Railway is likely to have upon it, and has been written

with a view of dispelling the delusion that appears to prevail, especially in England, that this Railway will act as the grand panacea by which our depressed Cotton Trade is once more to vie with, and to rival that from America.

The second and third chapters are devoted to a consideration of the general direction, in which the proposed Great Indian Peninsula Railway ought to be carried to ensure the greatest benefits being derived from it by all classes,—the inhabitants of the country, the Indian Government, and the Railway proprietors; as well as those modifications in the actual construction of the line, which the author believes to be absolutely necessary to make an English system of Railway Locomotion suitable to India, derived from an experience of twenty-seven years in the country. Whilst fully acknowledging the extraordinary skill and science with which these works have been perfected in England, he would deferentially suggest that it is possible that a difference of upwards of thirty degrees of latitude and seventy of longitude may require some deviations from the precise details of even an English Railway, which, though not occurring to even Professional Engineers unacquainted with this country, are perfectly obvious to those who have passed the greater portion of their lives in the land into which this English system is sought to be introduced.

The author has, therefore, endeavoured to place the whole subject in as clear a light as possible, in the firm belief that a faithful and unprejudiced exposition of the facts, however unpalatable they may prove to some, is in truth the surest mode of advancing the

eventual interests of the Railways, and causing them to become (all of which they are capable of becoming) as practical preachers of a crusade of civilization in the East, conquering time with the rapidity by which they have already restricted space,—thus doing greater things in one year by instilling into the minds of the natives of India the blessings and advantages to be derived from the introduction of Science into their walks and ways of life from the economy of time, and from mental energy and exertion, than could be effected in a century by any other means, in rousing their apathy, exciting their emulation, and advancing their mental and physical state.

POONA, *December 12th*, 1849.

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CHAPTER I.

In a pamphlet entitled "Railways for Bombay," published in Bombay in 1849, four points are particularly insisted upon;—1st. That the Americans are fast rivalling us in the English markets with their Cotton;—2nd. That they are enabled to do this by means of their railroads, conveying their Cotton to their Shipping Ports, at a rate which a few years ago would have been incredible, enabling it to be sold in the English Markets at prices threatening ere long wholly to destroy the consumption of Indian Cotton—3rdly. That the most important cause of the decline of Commerce in Western India, especially its Cotton trade, is the defective internal transport; and, 4thly. That this evil can best, or, indeed, only be remedied by the construction of Railroads in India. With regard to the first and second of these points, there can be no doubt of the fact, that America is seriously threatening to drive our Indian Cotton out of the English Market, which she is partly enabled to do by having, between 1830 and 1847, constructed 5740 miles of Railroad, bringing her inland produce to her Shipping Ports at an extremely low rate. With respect to the last two points urged in the pamphlet, the facts and consequences are by no means so apparent, it being far from certain, that the declining state of our Cotton Trade is owing to the defective nature of internal transport; or that the introduction of

Railways will, to so great an extent, remedy the evil. In all that has been written on the subject one material point appears to have been overlooked, or not sufficiently considered,—namely, that by far the greatest portion of the Cotton exported from Bombay, as well as the best in quality, is brought to Bombay by *sea*, and therefore if the Cotton from Surat, Broach, Dollera, &c., cannot *now* compete with that from America, in the English Market, it is difficult to see, how the projected Railroad which will not pass within 120 or 150 miles of these districts, can in any way assist these Cottons in combating the American rivalry; or that if, when "Surat Cotton is quoted in Liverpool at threepence per pound for fair samples, it is *impossible* to look for the usual receipts from India," we can hope for any improvement in the price, or expect *any* profit from, the Cotton of our best and most productive districts by the establishment of the proposed Railway.

The following Table exhibits the quantity of Cotton imported into Bombay by sea during the years 1847-48, and as all duties on this article were abolished in January, 1846, the Table exhibits probably nearly, if not the entire amount received into Bombay, which since the abolition of the duties has all been brought by sea.

	Bales of 3½ Cwt.
From the ports of Guzrat, ...	191715
From the ports in the Concan.	90386
From Goa, ...	41
From Compta, Canara, and other ports on Malabar Coast,	36890
From Cutch and Kattiwar, ...	24742
Total number of Bales, of 3½ Cwt. imported in 1847-48,	346804

The quantity imported in 1846-47 was as nearly as possible the same as the above. In 1845-46, before the reduction of the duties, only 231,061 bales were imported into Bombay by sea, but that was in other respects an unfavourable year, the Imports from Guzrat having been *one-third* less than in 1847-48.

From the foregoing it appears, first, that the Cotton from Guzrat comprises more than half the total amount imported into Bombay from all other places collectively; secondly, that it is more than double that of the Cotton imported from all the ports of the Concan, among which the Oomrawutty Cotton, as coming by the Bhore Ghaut and Panwell is included, a great portion of which could never be carried by the proposed Railway; thirdly, that this Cotton from the Ports of the Concan, which alone can benefit by the proposed Railway, exceeds but by *one-fourth* the total amount imported, and therefore the Railway, under the most favourable view, could only benefit one-fourth of the Bombay Cotton districts, and in so doing cannot be looked upon as a panacea for the general improvement of our Cotton Trade.

That the Guzrat Cotton is not only the most abundant, but is also the best of our Western India produce, whatever the qualities of particular experimental growths may be, is shown by the fact of its bearing a higher price in the market than any of the other Cottons. At the sales in Bombay, of August, 1847, the prices fetched for new Dollera Cotton was 93 rs. per candy, whereas the highest price that any of the eastward or southward Cottons fetched, was 87 rs. per candy: the average quoted prices of these Cottons being 84 to 85 rs., whilst that of Dollera was 93 rs., and that of Broach and Jumboosur 91 rs. per candy of 7 cwt.; in September, Dollera was sold for 98½ rs. per candy, and in October for 101 rs. per candy.

The construction of the proposed line of Railway from Bombay to the eastward, can, therefore, in no way ameliorate the prospects of the Cotton trade from ports due north of Bombay, from which our best and chief supply of this article is derived.

And as none of these Guzrat Cottons, with the exception of a little of that grown in the Ahmadabad Collectorate, have probably to be carried a greater distance than twenty, or at most twenty-five miles,

to their shipping ports, whence they are conveyed by boat to Bombay, at a very trifling cost, it can scarcely be said that it is to the defective nature of *internal* transport, that the declining state of our Cotton Trade is owing.

Neither ought we to look to the construction of the proposed Railway, to assist much in improving the present state of things; for it can scarcely be expected, that however cheaply this Railroad may convey Cotton from the interior of the country to Bombay, that it even then could cost so little in transport as the coast-grown Cotton of Guzrat, especially when it is considered at what an extremely low rate the native Cotton-boats are navigated, and the large cargoes they carry during the fair season.

It cannot, therefore, be said that it is the expense of the inland transit, and the loss and deterioration of the Cotton on the road, which has enabled the American Cotton to compete with that from Western India, generally in the English market:—true, the Americans could not so compete with us, until they had, by the construction of Railroads, been enabled to transmit their *inland* Cotton to their sea-ports, at a moderate cost; but the Cotton which they now threaten to drive out of the market, is not *inland*, but *coast* Cotton, for such the Guzrat Cotton may be considered; and, therefore, it by no means follows, that because, by the construction of Railways, the Americans are now bringing their Cotton to the English markets, at a cheaper rate than we can supply Cotton of an equal quality from India, that, therefore, by the introduction of Railroads into India, or at all events, by the projected Railway, we shall be enabled, once more, to drive the American produce out of our markets.

Had Berar, Candeish, and the Southern Mahratta country, been the Cotton districts with which the Americans had, until the establishment of their Railroads, been unable to compete, but which the introduction of

this expeditious and cheap mode of transit had now admitted of their successfully entering the market against, then doubtless the construction of a better system of inland communication, might in its turn, have improved the prospects of this *inland* Cotton ; but, as it is our *coast* Cotton that is being beaten out of the field, it is difficult to understand how the introduction of the proposed Railway will benefit its prospects.

In an indirect manner, the Railway will probably do good, for if the inland Cottons, can be brought to Bombay at a much lower rate than it now is, it will oblige the Guzrat Cotton-growers and exporters to improve the staple of their produce, and to cease from deteriorating it, as they now do, to enable their staple then to hold its own in the market; and thus by a side movement, eventually to benefit by the proposed Railway.

In stating that the declining state of our Cotton trade *generally* could scarcely be attributed to the defective nature of the internal transport, the writer more particularly alluded to the establishment of the Grand Trunk Railway from Bombay, which will not pass within 120 miles of the Guzrat Cotton districts, for he is far from thinking that the nature of inland transit in these Guzrat districts does not admit of, and, indeed, loudly call for, very great improvement; for although the Cotton-fields may none of them be more than twenty-five or at most thirty miles from their shipping ports, still this twenty-five or thirty miles of track—for roads there are none—are as bad, as bad can be, and doubtless entail an amount of labour in transferring the produce, which need not, and ought not to exist.

It is, therefore, strongly recommended, that previous to placing too much faith upon the resuscitation of our Cotton trade, by the proposed Railway, the means of conveying the Guzrat Cotton to its shipping ports should be greatly improved, as well as the conveniences of shipping it on board the native boats; in fact, that

every means and pains should be *at once* taken, to endeavour to improve the transit to Bombay of the Cotton from the valuable districts of Guzrat and the Gulf of Cambay, which, whatever the amount of saving might actually be, would, at all events, serve as an index to show what we have to expect from an improved mode of conveyance, and whether, however much this may be improved, and its cost lessened, we can long continue to compete, with the daily increasing advantages of the cheap transit of the American Cotton to its shipping ports.

It is by no means intended by the above remarks to discourage the prospects of our Indian Railways, possessing so many other sources of profit besides that of carrying Cotton, which, indeed, is only estimated as forming one-tenth of the expected goods traffic, such as Linseed, Hemp, Sugar, Salt, and various other agricultural products, *which a means of transport to a market* will, it is believed, call into existence, and produce a corresponding demand for our English manufactured goods. But to show how little effect the completion of the Great Indian Peninsular Railway can have upon our Cotton prospects generally, or for some time to come,—and procrastination is, in this instance, annihilation, as has been well remarked by the author of "Railways for Bombay" — "all history and experience teach us that when from any causes an old-established trade has once begun to decay, the progress of decline can only be arrested by the most extraordinary and timely exertions in removal of all those causes; *that if such exertions be delayed*, if remedial measures be not speedily and energetically adopted, and if the commerce should be once dissipated, it can *never* be recalled; no human power can ever charm it back into its old deserted channels, or restore what little of it remains, to its original life and vigour," so that whatever is done, must be done quickly.

The foregoing remarks have also been intended to

question the accuracy of the opinions which have been put forward, that the establishment of Railways in India will prove the grand panacea for the revival of our Cotton Trade—for the continued existence even of which it is believed, that something besides grand lines of Railway is required; for it cannot be expected that any system of Railway transit, however applicable for other purposes, can, in India, carry such a bulky article as Cotton, the first cost of which at the place of growth, is only $1\frac{1}{2}d.$ per lb., to Bombay at so low a rate, as it can now be conveyed from the ports of Guzrat, by one of the cheapest modes of transport in the world, that of native boats navigating a quiet sea in fair weather, and with a certainty of fair wind.

The average freight of Cotton by native boats from Broach and the ports of Guzrat is $2\frac{1}{2}$ rs. or 5*s.* per candy of 7 cwt., and about 5 annas, or $7\frac{1}{2}$ pence for landing the same in Bombay, or 191 pence per ton, which at $2\frac{3}{4}d.$ per ton would convey the same quantity of Cotton seventy miles only by rail, whereas Broach is 248 miles by land from Bombay, and Tankaria Bunder very much more, so that there is little chance of Guzrat Cotton being carried to Bombay by rail, while it would cost upwards of three times the amount for carriage that it now does by sea.

Instead, therefore, of looking to the construction of a Grand Trunk Railway penetrating the country to the eastward of Bombay, as the grand hold-by, wherewith to save our Cotton interests from the death-blow with which they are threatened by the low price at which the Americans are now enabled to bring their Cotton to our English markets, the first attention of those interested in the matter should be directed to try whether the cotton crops from decidedly the best Cotton-bearing districts—namely, those of Guzrat, cannot be improved, *in se*, independently of the means of transport.

The experimental Cotton Farms, established some

few years since, and on which it was said that as many as ten or twelve lakhs of rupees have been expended, have now lately been abolished ;* but it is conceived, that although they may not have answered the expectations of Government, much valuable information must have been acquired, as to the nature of soil most suited to the growth of Cotton, the effects of a sufficient supply of water upon the crop, the best seasons for sowing the seeds, and the description of Cotton producing the largest return of the best staple. Some eight hundred bales sent home, this year, from the Coimbatore districts, appear to have been highly approved of, and valued in England, so that it is to be hoped, that by this investment, some of the above data will have been furnished, though still a great deal remains to be done.

Through the kindness of Dr. Porteous, the Civil Surgeon at Coimbatore, who furnished the author of this paper with specimens of the common native Cotton, or Oopum, or Cuppas, the American, or New Orleans Cotton, and of the Egyptian Cotton, all grown in the Coimbatore district — the latter from seed sent to Dr. Porteous expressly for trial—the following results have been obtained :—

NATIVE COTTON, OOPUM, OR CUPPAS.

		GRAINS.
Weight of uncleaned Cotton, as received from the Ryott		100
Number of seeds covered with fibre—100.		
Total weight of seeds when cleaned	74	100
Total weight of cleaned cotton obtained from these seeds	26	
or, about *one-fourth*, or 26 per Cent. of clean Cotton to total weight of Cuppas.		
Weight of each seed covered with fibre		1

* When this was written, the Superintendent of the Government Farm at Coimbatore had just been removed from his appointment, and every thing belonging to the Farms, ploughs, hoes, spades, &c. &c., sold by the peremptory orders of Government. It now appears, however, that there was some mistake in this, and that the Indian Government are perfectly satisfied with the results of their Cotton Farms.

EGYPTIAN COTTON.

		GRAINS.
Weight of uncleaned Cotton		100
Number of seeds covered with fibre—57.		
Total weight of seeds when cleaned . . .	72	100
Total weight of cleaned Cotton obtained from these seeds .	28	
or, somewhat *more than one-fourth*, or 28 per. cent. of clean Cotton to total weight of Cuppas.		
Weight of each seed with fibre adhering		1·4

NEW ORLEANS, OR AMERICAN COTTON.

		GRAINS.
Weight of uncleaned Cotton . . .		100
Number of seeds covered with fibres—45.		
Total weight of seeds when cleaned . . .	64	100
Total weight of cleaned Cotton obtained from these seeds .	36	
or, more than *one-third*, or 36 per cent. of clean Cotton to total weight of Cuppas.		
Weight of each seed with fibre attached		$2\frac{1}{4}$

COTTON GROWN BY THE COLLECTOR OF COIMBATORE FROM EGYPTIAN SEED ON ABOUT 100 ACRES OF LAND.

		GRAINS.
Weight of uncleaned Cotton		100
Number of seeds covered with fibre—42.		
Total weight of seeds when cleaned . . .	$66\frac{1}{2}$	100
Total weight of cleaned Cotton obtained from these seeds .	$33\frac{1}{2}$	
or, exactly *one-third*, or $33\frac{1}{2}$ per cent. of cleaned Cotton, to total weight of Cuppas.		
Weight of each seed with fibre attached . . .		2·1

COTTON GROWN BY DR. PORTEOUS AT COIMBATORE, FROM EGYPTIAN SEED.

		GRAINS.
Weight of uncleaned Cotton		100
Number of seeds covered with fibre—42.		
Total weight of seeds when cleaned . . .	70	100
Total weight of cleaned Cotton obtained from these seeds .	30	
or, 30 per cent. clean Cotton to total weight of Cuppas.		
Weight of each seed with fibre attached . . .		2·4

From the above experiments, which have been tried from two separate parcels of Cotton, without varying one grain, can scarcely fail from being correct, the following results are obtained :—

		POUNDS.
For every 100 lbs. of cleaned Cotton wool there would be required of Native Oopum, or Cuppas		384
Of Egyptian Cotton		357
Of New Orleans American Cotton	only	279
Of Cotton grown at Coimbatore from Egyptian seed		299
Of Cotton grown by Dr. Porteous at Coimbatore, from Egyptian seed		333

which shows the immense advantage the New Orleans Cotton possesses over the other kinds in proportion of weight of fibre to total weight of Cotton grown. Supposing the number of seeds to be the same in one pod of each kind, one pod of American Cotton will produce an equal weight of Cotton, to $2\frac{1}{4}$ pods of Indian Cotton, and to $1\frac{3}{4}$ pods of Egyptian Cotton.

If the fibre is spread out round the seed, so as to admit of its length being measured, that is the average length of fibre from the seed, we find that,

			INCH
Native Cotton	$\frac{9}{16}$	=	$\frac{1}{2}$
Egyptian Cotton	$\frac{15}{16}$	=	1
American Cotton	$\frac{11}{16}$	=	$\frac{3}{4}$
Coimbatore Egyptian Cotton	$\frac{12}{16}$	=	$\frac{3}{4}$
Dr. Porteous, at Coimbatore, from Egyptian Seed	1[illegible]/16	=	1

Hence the Egyptian has the longest fibre.

The Native Cotton has only a little fibre on the seed, and that short and coarse.

The Egyptian Cotton has a light covering of fibre on the seed, but this is beautifully silky, and very long.

The Egyptian Cotton grown by the Collector of Coimbatore, is very thickly covered with fibre, tolerably long, white, soft, and very clean.

The Egyptian Cotton from Dr. Porteous' garden, is tolerably well covered with fibre, which is long, soft, but of rather a yellowish colour; the staple is longer, but the seed is not so thickly covered with fibre, nor is it so clean and white as that grown by the Collector.

The New Orleans Cotton is *thickly* covered with fibre, tolerably long, fine, and very strong.

In fact, the American Cotton, and the Egyptian Cotton, grown by the Collector of Coimbatore, have all the appearance of a fruit in full vigour and perfection, whilst the Indian Cotton appears only half developed, and as of stunted growth. In all the foregoing examples, the fibre was detached from each seed separately, by hand; from the native seed, it is tolerably easily separated, leaving a furry coat; but the seeds are so very small, weighing, when cleaned, only three-fourths of a grain each, that it requires the churka, or machine, by which they are separated from the seed, to be very correct, otherwise the seeds are drawn between the rollers and crushed. From the Egyptian Cotton-seed, the fibre separates most easily, appearing to have no adherence to the seed except at the end, whence the whole bunch of fibres appears to issue, being the same species as the Sea Island Cotton. The seeds are considerably larger than those of the Native Cotton, quite black and clean, and heavy for their size, weighing when cleaned $1\frac{1}{3}$ grains each. To the New Orleans or American seeds, the fibre adheres very firmly indeed, requiring considerable force to separate it from the seed, and then leaving a furry coat, for which reason the saw-gin is better adapted for cleaning this cotton than the churka; the seed is very large, of a light olive colour, each seed weighing when cleaned $1\frac{1}{2}$ grains; this furry coat is peculiar to the short-fibred Cotton. No doubt, the most correct means of ascertaining the comparative merits of these several kinds of Cotton, is by trying them on a large scale; but one very important fact is shown by the above data, namely, that to produce 100 tons of Cotton-wool, or fibre, requires of Common Native Cotton, or Cuppas, 384 tons, and of American, or New Orleans Cotton, only 279; or *one-third more* in weight of Native Cotton must be grown to produce an equivalent quantity of Cotton-fibre, or wool, than that from American seed.

The Egyptian seed is much better covered with fibre

than the native Cuppas, but this fibre is so silky and fine as to *weigh* very light, which, as Cotton is sold by the weight, must be the criterion of comparison, and therefore in the above respect it does not much excel the native Cotton, though apparently a much finer and more valuable article.

The Cotton grown by the Collector of Coimbatore from seed obtained from Egyptian seed, is apparently a very superior sample, and has been highly approved of in England, and fetched a high price: it was grown on about 100 acres of land that had been lying waste. The Cotton was planted in ridges, but not on raised furrows, and was carefully weeded and attended to. Some of the pods were of an extraordinary size, one weighing 150 grains, and as large as the tuft on a soldier's cap, and beautifully white and clean, presenting a most marked contrast to the small wretched pods of the native Oopum, showing most forcibly the advantage of substituting fresh and vigorous for the deteriorated and worn-out seed of the Indian Cotton. The soil in which this Cotton was grown is a rather light gravelly dry soil, about seventy miles from the sea in a direct line, but apparently within the influence of the sea atmosphere, as may be inferred from the tops of cocoa-nut and other palm-trees which grow there. This Cotton has been highly approved of by competent judges in Bombay, and is said to be fully equal to the real Egyptian. As 100 acres were cultivated, from which these samples were obtained, this cannot be looked upon as a mere *garden experiment,* but as showing the probable produce of the district if generally thrown into Cotton culture.

The above is sufficient to show that these several descriptions of Cotton vary greatly in every particular, and that where *quantity* and a good return, with a good staple, are required, the American Cotton far exceeds the others in these respects; but where a very fine silky

long fibre is the object, the Egyptian variety appears to great advantage, especially that grown by the Collector of Coimbatore, which in *quantity* even equalled the New Orleans. Although it does not appear that Government has derived that benefit from the experimental Cotton farms that it anticipated, yet, considering the paramount importance of improving the growth and staple of the Cotton of India, so as to enable it to continue to compete with the daily increasing advantages under which Cotton is grown in America, and can now be imported into England, it is most advisable still to persevere in this object, though probably by a somewhat different method from that hitherto pursued. Were even 10,000 rs. or 1000*l.* worth of seed from different countries distributed among the native cultivators in the Western Presidency *gratis*, and prizes given to those who produced the most abundant, and the best staple, in addition to purchasing all the Cotton thus grown —it is believed that a practical knowledge would be obtained of the description of seed most suited to the climate and soil, and of the most successful mode of cultivating the plant. Where opportunities offer of trying the effects of irrigation on Cotton, the same might be done by allowing the water from the tanks and dammed Rivers to be drawn off free of charge, the seed distributed gratis, and prizes offered for the most successful crops as above, and by thus giving the natives all the advantages, without imposing upon them any of the risks of the experiment, they might readily be induced to carry out the trials. Although this would entail a certain dead sinking of present capital, it is believed that more knowledge and experience would be obtained for a certain outlay than by any other means; and something of the kind is absolutely necessary to save our Cotton Trade from positive ruin. When we see that an expenditure of seven lakhs of rupees on the Coleroon Amicutts of the Madras Presidency, has in *nine* years realized a *clear* profit of *fifteen* lakhs, surely there is

ground to hope eventually for a good return for money thus laid out in improving the culture of our Cotton. Nothing can be finer than the soil of the Guzrat Cotton-bearing districts, or more suitable for the growth of that plant; but the crops are frequently most scanty, from the lightness of the monsoon, and the small supply of rain when the plants are stunted, causing the pods to be little withered things scarcely worth the picking; whereas the same soil, the same seed, and the same culture, assisted by irrigation, would, it is believed, have changed those stunted plants to fine bushy shrubs, and substituted large fat, well-filled pods, for the withered berries not deserving that name.

That the growth and produce of Cotton may be greatly improved by irrigation, even in India, has been found by experiment, and the advantage of applying this mode of culture to Cotton can only be questioned, by the consideration, whether the additional expense incurred, would be repaid by the increased amount of the crop and its improved quality. Nothing appears more susceptible of improvement from culture, and a regular supply of water, than Cotton; in fact, the Cotton of the common field, and that of the irrigated bed, can scarcely be recognised as the same plant, not only do the shrubs attain an increased size, and bear more numerous pods, but each pod is much larger, and contains a much greater quantity of fibre; indeed, our Indian Cuppas has all the appearance of a degenerated plant, of which the seeds have gradually diminished in size and powers of production. Perhaps, no country offers better opportunities for applying irrigation to Cotton culture on a large scale than the districts of Surat and Broach, particularly the former; or the land lying between Surat and Broach, bounded throughout its length by those two noble rivers, the Nerbudda and the Taptee, running nearly parallel to each other, at a distance of from forty to fifty miles apart; from the nature of the oils and country, offering every facility for the construc-

tion of a Canal. All the subsoil of these districts consists of a moderately hard moorum, or indurated earth, which not being difficult to excavate, would retain the water, and is of a sufficiently tenacious quality to admit of the banks being made of a high angle.

Were a Canal cut from the left bank of the Nerbudda, a little above the city of Broach, to the Taptee, near Surat, it would be somewhat more than forty miles in length, and would intersect throughout its course the finest possible Cotton soil. The point at which the Canal would leave the Nerbudda being some thirty miles from the sea, whereas it would join the Taptee about ten miles from the sea, there could be no fear of a sufficient fall throughout the Canal. From this main channel the small nullas that here run westward to the sea, might be filled, and small branches might be cut, as the undulations of the ground afford opportunities for running into the country in such a manner as to bring an immense tract into irrigated cultivation, the main Canal serving not only for the purposes of irrigation, but also to convey the produce of the fields to the shipping port, Surat, and affording the means of drainage from excessive rains. From the right bank of the same river, about fifteen miles above Broach, near the village of Shahpoora, a smaller Canal, about twenty miles in length, might, it is believed, be carried to the Gulf of Cambay, by the village of Nyor, near Ahmode, thus intersecting the Broach Pergunnah, as the distance to the sea by the Canal would in this case be only fifteen or twenty miles, whereas, by the river itself, it is fifty miles, thus securing a sufficient fall.

These two instances have been mentioned, as apparently, especially the junction of the Taptee with the Nerbudda, offering peculiar facilities for applying the principles of irrigation and drainage to Cotton culture; but there are numerous small rivers throughout the districts of the Bombay Presidency which admit of having

dams thrown across them at a very moderate expense affording a constant supply of water for the purposes of irrigation. Although this has been done in Candeish to a very trifling extent, it is painful to see the magnificent volume of water, that for four months at least of every year, runs fruitlessly to the sea, which, if but a fraction of its contents were retained, would fertilise whole districts that, now parched and dry, witness the passage of what they so much need flowing by unheeded.

With an annual supply of water from the heavens, of ten to twelve feet in depth, all along the Western Ghauts, at Mahableshwar, upwards of 230 inches, or nearly twenty feet, of rain fall in four months of the year. Few parts of India afford better opportunities of cultivation by irrigation than a great portion of the Bombay Presidency; although, strange to say, scarcely any advantage has hitherto been taken of this valuable assistant to agriculture. India possesses the three grand requisites for the most abundant and luxuriant cultivation,—a rich soil, great heat, and great moisture. The two former are always available, but the latter is supplied during four months of the year, the remaining two-thirds of the year scarcely affording any. To benefit by these natural advantages, it is absolutely necessary that means should be taken to secure to the land, throughout the year, that moisture which is communicated during only one-third of that time, which can only be done by retaining the water, or a certain portion of it, that now runs by the river channels uselessly to the sea, in such a manner as to admit of its distribution, throughout the year, over the country for the purposes of irrigation. This is accomplished either by storing the water up in large tanks or reservoirs, or by constructing dams across the rivers, by which the water flowing down them is retained at a sufficient height to run over the adjacent lands.

This principle had long been acknowledged in India,

even before we took possession of the country, and has been acted up to in the other Presidencies; in that of Madras alone, it is estimated that the value of the crop thus *yearly* grown by means of irrigation is upwards of four crores of rupees, or 4,000,000 sterling, yielding a revenue to Government of upwards of *one and a half crore of rupees.* The dams constructed across the Coleroon river alone have returned a clear profit of fifteen lakhs of rupees in nine years, after paying the whole of the expenses incurred in its construction, and the great similar undertaking on the Godavery, will, it is estimated, bring 100,000 acres of rich soil into the most profitable cultivation. In Bengal, the works of irrigation are on a very large scale, the great Dooab Canal is again in progress, and it has been stated that five lakhs of rupees a-year have been allotted for the works of irrigation and the improvement of internal communication in the Punjaub, whilst in the Bombay Presidency, affording, as it does, such facilities for artificial irrigation, scarcely anything has as yet been effected.

One of the great advantages of irrigating from Canals, is the improvement effected upon the soil: the water of such Canals is always turbid, and contains a large amount of soil in suspension, which is thus conveyed to the fields, where it is deposited, not only by its humidity causing the plants to grow, but constantly supplying to the soil the substances withdrawn from it by cultivation. To this cause, doubtless, in a great measure, the fertility of Egypt and Scinde, countries irrigated by the waters of great rivers during their inundations, is to be attributed, these being charged at such times with sedimentary matter, incessantly restore the elements required for the favourable developement of vegetation.

Sir Charles Lyell, in his "Principles of Geology," states on the authority of Mr. Everest, that the average quantity of solid matter suspended in the waters of the Ganges during the rainy season, was by weight

$\frac{1}{428}$th part, or $\frac{1}{856}$th part in bulk, and that it was calculated that the Ganges thus brought down 577 cubic feet of earthy matter *per second*, from which the enormous quantity of soil actually spread over the surfaces of land irrigated by the turbid waters of such rivers may be imagined; by which bountiful arrangement, not only are countries, in which rain scarcely ever falls, such as Egypt and Scinde, rendered the most fertile in the world; but the land, so far from being impoverished by vegetation, has its productive capabilities restored by the very act of cultivation; indeed, in Scinde some tracts of country that were formerly in full cultivation from irrigation, have now become quite salt, owing to the inability of the proprietors to keep it in cultivation, by which it has now been for some time deprived of the fertilizing effects of the annual irrigation.

The construction of a small Canal, forty miles in length, would probably cost 300,000 rupees, or 30,000*l.*; a large sum in the abstract, but a trifle compared with the benefits that would be derived from it. The writer would, therefore, urge those interested in the future welfare of our Cotton cultivation, not to look too much to the benefits to be derived from the introduction of Railways into India, but at the same time to pay attention to the improvement of the culture of the plant; as it is believed that by so doing, more will be accomplished towards enabling our Indian Cotton to compete with that from America in our English markets than by the introduction of Railways, which will never lessen to any extent, the cost of the Cotton from our best and most productive districts.

A very little consideration will show the truth of this assertion. The Coimbatore Cotton is now carried to its shipping ports on the Western Coast for *one-sixth* of a penny per pound, whilst the cost of conveying the Guzrat Cotton from Broach and the other Ports by native boats, including the expense of landing it in Bombay, does not exceed *one-tenth* of a penny per pound.

Now Broach is 248 miles from Bombay by land which at $2\frac{3}{4}$ pence per ton per mile, would cost to carry Cotton by rail about *one-third* of a penny per pound, or three times the cost of freight by sea, from which the advantageous effects of the introduction of Railways on our best Cotton districts may be judged. But, on the other hand, the Cotton grown by the Collector of Coimbatore from Egyptian seed has been declared by competent judges fully equal to the real Egyptian Cotton, and is probably worth upwards of sixpence per pound, so that if by introducing fresh vigorous seeds, and improving the system of cultivation the value of Indian Cotton can be raised from threepence or fourpence to sixpence per pound, it will do more for the revival of the Cotton Trade in India than intersecting the whole country with Railways. Whilst the proposed Bombay Line, which, as above shown, can never in the slightest degree benefit our best Cotton districts, will not ever pass within 140 miles of Oomrawutty and the Cotton lands of Berar, about which so much fuss (pardon the expression) has been made, instead of penetrating, as supposed in England, and as stated in the English journals, into the *heart of the Cotton country*. Let those interested both in the Railway, and in the improvement of our Cotton Trade, bear this in mind.

With the hope of still further elucidating this most important subject of the improvement of our Cotton culture, the author is induced to notice in a cursory manner some important information and observation on this subject derived from various sources.

In the valuable " Treatise on the Cotton Manufactures of Great Britain," by Dr. Ure, published in London in 1836, a vast amount of practical experience is recorded regarding the cultivation of the Cotton plant in America, where, to our cost, this shrub has been so extensively and so successfully reared of late years, and as the information given by Dr. Ure is derived from men who have raised the produce of Cotton in America

from 5340 bales exported in 1794 to 2,600,000 bales the present estimated crop, it must be allowed that their knowledge of the subject is the result of successful experience.

In the cultivation of Cotton the following facts appear to be principally insisted upon to secure a good and full crop.

Contiguity to the sea.
An alluvial soil.
Ridge cultivation.
Drainage to save the crops from inundation.
Irrigation to the crop when the rains fail.
Careful weeding and cleaning of the beds, and
Careful picking of the Cotton seed from the pod.

And when we remember that in 1835, Sea Island Cotton sold in Liverpool for 2*s.* 6*d.* per pound; Demerara and Berbice, for 1*s.*; Egyptian for 1*s.* 2½*d.*; New Orleans, 1*s.*; Upland Georgia, 11½*d.*, and Surat, 8*d.* per pound, the advantages to be derived from good seed and careful cultivation are very apparent; for although the price of all Cotton has fallen, still good Cotton will probably bear the proportional price to bad Cotton, that it did in 1835.*

First, as to contiguity to the sea. This is insisted upon by all the American planters. "One point," says Dr. Ure, "is clearly fixed, the superiority of Cotton near the sea to that grown inland," a fact borne out by the Cotton fibre having been found by analysis to contain sixty-four per cent. of soluble salts. "The only essential point," says an experienced American planter, "seems to be a saline *atmosphere*; with it, any soil in Carolina or Georgia, may produce fine Cotton; *without it*, no soil will do so." — "The Sea Island Cotton of Georgia, &c., is grown within fifteen miles of the sea; wherever its cultivation has been attempted beyond these limits, a certain decline of its quality has been observed to take place." "The cultivation of this valu-

* See Note E, Appendix.

able shrub extends about forty-five miles from the sea-shore," says another planter, "in the States, and its fruit diminishes in all its valuable properties in proportion to its distance from the atmosphere of the ocean." "As salt is considered to promote the growth of Cotton, the old lands in Guiana are frequently inundated with salt-water." And that it is not solely to the Sea Island Cotton that these remarks refer may be assumed from the following observation by a planter: "It may be remarked, however, that the *short stapled* wool is of a better quality, when raised near the sea, than at a distance from it." "It thrives most luxuriantly in alluvial soils a little impregnated with salt."

With such facts before us, why should we seek to improve our Cotton trade by lessening the cost of transit to Bombay of Cotton grown some hundreds of miles from the sea, rather than endeavour to strike at once at the root of the evil, by an improvement in the quality and *quantity* of the Cotton grown in the most favourable localities for its produce? Guzrat, is a country fulfilling all the requirements above described, as essential to the successful cultivation of this plant—a country that has for centuries been proverbial for the quality of its Cotton, a fact referred to by Marco Paulo about the middle of the sixteenth century, whilst in the year 1608, a boat was met with bound from Guzrat to Aden, with a cargo of Cotton cloths, chintzes, &c.

All the Cotton in America is sown on ridges, more or less high, according to the nature of the soil and description of Cotton. Cotton having a tap-root imbibes moisture from the water in the furrows, whilst being grown on a ridge, the roots are preserved from the actual contact of the water, which rots them.

Drainage is therefore strongly insisted upon. "In Virginia, Cotton will grow in any soil, clay, loam, or sand, provided the water be kept well drained from the surface of the land." "Upon the coast of Guiana, the Cotton land is surrounded by drains, to prevent

that stagnation of water round the roots of the Cotton so injurious to the growth." Many more extracts might be made as to the necessity of keeping the roots of the Cotton free from wet, but the above are sufficient.

This necessity for drainage appears to be perfectly unattended to in Guzrat, where, during heavy rains, the whole country for miles is under water, and the plant being sown on the plain surface of the ground, *and not upon ridges*, as it is in America, such inundations frequently destroy the whole crop. In the *Bombay Telegraph and Courier*, of September 17, 1849, it is stated, "We are sorry to hear that the recent heavy fall of rains has been very injurious to the crops in Guzrat; the country is stated to be in many places a *perfect swamp*, and the agricultural produce all but destroyed."

The necessity for a system of efficient drainage for Cotton lands is therefore very apparent.

Next, as to irrigation. "In Syria," says Dr. Ure, "the Cotton plant is treated in the same manner as the vine, and it yields every year a good crop by means of ploughing and irrigation." This irrigation is performed as often as is thought requisite, generally about every fifteen days. "In Abyssinia," says the late Sir William Harris, in the Appendix to his 'Highlands of Æthiopia,' "the Shrub (Cotton) varies, according to the locality and supply of water, from three feet in height to upwards of seven," and the author is informed by Captain D. C. Graham, one of the members of the Mission to Shoa, that the Abyssinian Cotton is entirely cultivated by irrigation from the numerous rills which flow through the Cotton plains. In Egypt, where, within a few years, such a surprising success has attended the introduction of Cotton as an article of culture, the plant is entirely grown by irrigation, as well as in many other places. That it may also be successfully treated in this manner in India, may be seen from the

following extract of a letter from Captain Lawford, of the Madras Engineers, to the Editor of the *Madras Athenæum* newspaper, dated Upper Annicut, Trichinopoly, 19th May, 1849. " To compare this (American Cotton) produce with that of the indigenous variety, I sowed both, under exactly the same circumstances, and the result is, that the American has not only yielded a much finer Cotton, but its produce has been matured in half the time, and is 500 per cent. greater in quantity than that of the Indian plant."

This tends to support the idea that the Indian seed has become degenerated, and should be replaced throughout the country with fresh American, or other seed. Captain Lawford expects that irrigation will make the plant a perennial. The American Cotton had produced one crop, and was covered with a second crop of flowers, and even pods, whilst that from Indian seed sown at the same time was only producing its first crop. Captain Lawford calculates that were 400,000 acres out of the 700,000 acres irrigated by the Cauvery, cultivated with Cotton, they would produce eighty-eight and a half lakhs of rupees, while the produce of Paddy or Rice from the same land is fifty-seven lakhs only. These are encouraging facts; and by means of the two canals previously proposed from points in the Nerbudda, a little above Broach to the Taptee, near Surat, in one direction; and the Tankaria creek in the other direction; the whole of the Broach, and a considerable portion of the Surat collectorate might be cultivated by irrigation. The Canals would answer equally for the *drainage* of these lands, now frequently inundated with water, to the destruction of the crops; and the extremes of either too much or too little water, both equally injurious to the Cotton plant, might be avoided.

In the descriptions of the cultivation of Cotton in America, great stress is laid upon the necessity of carefully weeding, and keeping the crops free from all ex-

traneous vegetation, a point, although acknowledged in India, seldom sufficiently attended to.

The Cotton seeds are also most carefully picked from the pods in the fields in America; the greatest pains being taken to prevent any admixture of broken dry leaves, or dirt of any kind with the Cotton; the advantage of attending to which cannot be too much insisted upon, independent of its eventual economy.

Cotton is said not to exhaust the ground—" but if cultivated continually on the same land, the plant becomes affected with a disease greatly resembling the blight in wheat, and its seeds have a propensity to extend the evil." A rotation of crops is, therefore, strongly insisted upon.

In the above extracts from the opinions of the most experienced Cotton planters in America, two points may be noticed, namely, that their great object is to obtain the largest supply of the best quality of Cotton from a given area; to secure which, they spare no pains or labour in the cultivation of the plant, whilst in India, among the natives, the principle is to get as much as you can with the least labour and outlay.

Some valuable information regarding the cultivation of Cotton is contained in a treatise on the Zillah of Broach, by Lieut-Col. Monier Williams, late Surveyor General, Bombay Presidency, published by Cox and Baylis, London, 1825. The Zillah of Broach contains an area of 1319 square miles, of the cultivated portion of which *five-sixths* consist of the Kalee Bhow, or black Cotton soil; and one-fifth of the Marwar, or light sandy soil. In 1817 and 1818 this Zillah produced 43,582 bars of Cuppas, or uncleaned Cotton, of 960 lbs., or 53,366 candies of 7 cwt.; or at one-third fibre to two-thirds seeds, about 17,788 candies of clean wool, the average price of which was 53rs. per candy of Cuppas, or 156rs. per candy of clean wool, after deducting 3rs. per candy for clearing and 166rs. per candy for the Cotton from the Broach and Jumboosur Pergunnahs. This quantity was

produced from about one-fourth of the cultivated land, as not more than one-third of this land can be sown with Cotton at the same time. In the Jumboosur Pergunnah each acre of land produced 384lbs. of Cuppas, or 128lbs. of Cotton wool. In America, as stated by Dr. Ure, the average produce of the Cotton farms is about 140lbs. of Cotton wool per acre of Sea Island, and about 125lbs. per acre the average produce of Cotton farms cultivated by the plough. In 1817 and 1818 the value of the Cuppas was more than four times that of the grain sown on similar ground.

"Cuppas is seldom sown more than once in three years in the same ground; to sow it oftener would be attended with no immediate advantage, and with certain prospective loss. A second year's crop does not turn out more than one half of the first." The Cuppas of Guzrat, the Gossipium Herbaceum, or Indicum, is an annual, hence the great advantage of making this plant a perennial by means of irrigation.

"The average proportion of weight of wool to that of Cupposea, or seed, is one-third wool and two-thirds seed." This is a much better average than it is believed this Cotton now yields.

"In the succession of crops Jowar succeeds Cotton, and then there should be a season of fallow. Jowar is the chief grain grown on the black soil. "Wheat is also grown, but it is a precarious crop."

In the Jumboosur Pergunnah, which is bounded on one side by the sea, Colonel Williams says that the dust from a tract of barren salt land bordering the shore is blown over the cultivated fields, to the *injury* of the crops, whereas it is probably owing to this salt that the superior Cotton of this Pergunnah is to be attributed. This Cotton is now (September, 1849) selling as high as 96rs. per candy. In 1817 and 1818 this Pergunnah produced about one-sixth of a candy of clean Cotton per acre, so that whether or not it has deteriorated in this respect could be easily ascertained.

In the Marwar, or sandy districts, very little Cotton is cultivated in the Broach Zillah, this soil being very favourable to the culture of grain; and the following table will give an idea of the comparative value of the different agricultural products of the district in 1817 and 1818 :—

NAMES OF CROPS.	Greatest reported produce per Acre in lbs.	Least reported produce per Acre in lbs.	Prices from an Average of Crops.	Value of Crops per Acre.	Quantity of Seed required to sow 1 Acre.
CORN CROPS.	Seers or lbs.	Seers or lbs.	1 Kulsy=16 maunds of 40 seers =640 lbs.	Rupees.	Seers.
Bajree, with Kuthur,	670	250	14 Rs. per Kulsy,	10	4
Kodra, alone, ...	1340	350	8 and 9 Rs. per Kulsy,	11	3
Baota, alone, ...	1680	350	10 and 11 Rs. per Kulsy,	$16\frac{1}{2}$	$3\frac{1}{2}$
Jowar, alone, ...	670	250	14 to 16 Rs. per Kulsy,	$10\frac{3}{4}$	5
Kuppas, alone, ...	590	170	70 Rs. per Bor. of 960 lbs.,	$27\frac{3}{4}$	6
Dangur, dry rice, alone	670	350	13 and 14 Rs. per Kulsy,	$10\frac{3}{4}$	18 to 20
Muth with Bajree, ...	170	,,	9 and 10 Rs. per Kulsy,	$2\frac{1}{2}$	$1\frac{1}{2}$
Tull with Toour, ...	250	80	40 Rs. per Kulsy,	$10\frac{1}{4}$	$\frac{1}{2}$
Toour with Tull, ...	170	60	14 Rs. per Kulsy,	$2\frac{1}{2}$	$\frac{1}{2}$

Hence, with the exception of Baota, Kuppas produces two-and-a-half times the value per acre of any kind of grain, but this was when Cotton fetched 166rs. per candy in Broach; but at the price to which it has now fallen in Bombay, of from 90rs. to 92rs. per candy, it can be scarcely worth while to continue the cultivation unless it be improved both in quantity and quality.

In the latter part of 1818, the price of Surat Cotton in Liverpool was 1*s.* 6*d.* per pound, which would yield triple its present profit, supposing the prices in India to have been 166rs. and 91rs. a candy respectively.

In 1815 only 22,357 packages of Cotton were imported into England from India, but owing to the great

increase in the price of Cotton that year, Colonel Williams says the cultivation of Cotton in the Broach Zillah was greatly extended, so much so, indeed, that in 1818 no less than 247,659 packages were received in Liverpool from India, or upwards of one hundred times the amount of import of 1815.

No sooner, however, had the Broach ryotts thus increased the cultivation of the plant, than the prices fell again in 1819 to an average of 10*d.* per pound, in 1820 to $8\frac{1}{2}$*d.*, and in 1821 to about $7\frac{3}{4}$*d.* per pound, a price which it has seldom, or ever, exceeded. Thus rapidly were the hopes of the poor Indian cultivators blasted, and the amount of the cultivation of the plant gradually diminished to 184,259 packages in 1819, and to 57,923 packages in 1820, since which it has varied, more or less, to 117,965 packages in 1835.

In 1829 the price of Surat Cotton at Liverpool was only 27*s.* 8*d.* per pound, and from 1827 to 1832 it was frequently as low as 3*d.* and $3\frac{1}{2}$*d.* per pound.

Whilst the Indian Cotton Trade has been thus gradually declining from its sudden burst of success in 1817-18, that of America has been as gradually and surely advancing from 124,939 packages, imported into Liverpool in 1806, to 763,199 in 1835, and it is believed much more now. The above details being taken from Dr. Ure's Treatise, which was published in 1836.

With freights from Bombay to England at 3*l.* 10*s.* to 4*l.* per ton, the cost of conveying Cotton from Bombay to England will not exceed one halfpenny per pound, and if the transit to the Shipping Port is reckoned at even one halfpenny a pound, including all charges, there would not be much to complain of in the question of carriage; but would this enable the Indian Cotton to compete with that from America in the English market? We believe not. Guzrat must be made to produce a larger supply of superior Cotton from the same area of ground before the Indian Cotton Trade can again revive. From Surat round the Gulf of Cambay to Gogo—in the

alluvial soils of the Deltas or embouchures of the Taptee, the Nerbudda, the Mhye, and the Saburmuttee (see map)—is contained the best locality, the best soil, and the most favourable circumstances of all kinds for the culture of Cotton, and it is to the improvement of the Cotton cultivation in these districts that we must look for the revival of the Cotton Trade of India; which improvement can be best obtained by a system of irrigation and drainage, and by discarding altogether the deteriorated seed of the Indian Cotton plant, and introducing in its place the fresh, fruitful, and vigorous seed of America or Egypt, which is found by trials on a large scale to be the best suited to this country; for even if the short stapled variety, or New Orleans Cotton, can only be produced in sufficient quantity, clean, and of a good fibre, there will be an ample demand for it, as one sort of Cotton (says Dr. Ure) "is seldom worked up alone in our Cotton mills, but two or three different kinds are frequently mixed up together; thus the cheap and short stapled Cottons of India must be willowed and corded along with some of the American Cottons to make them work to the best advantage."

But our recent acquisition of Scinde affords probably one of the most advantageous localities for the successful cultivation of good Cotton, for which Lower Scinde possesses every requisite—contiguity to the sea, an alluvial soil, and the means of irrigation and drainage to any extent by means of Canals filled by the Indus during the periods of inundation. As very little or no rain falls in Scinde, the exact quantity of moisture required for the best development of the plant, could be given by irrigation,—in fact, Egypt and Scinde are so similar in all these respects, that there can be no reason why Cotton should not be as successfully cultivated in Scinde as it has been in Egypt, whilst no complaints could be made on the score of transit to the shipping port. In Scinde, therefore, appears a great opening for the cultivation of the fine long-fibred or Egyptian

Cotton, which the plains of India generally do not produce, although it has been shown that Egyptian Cotton has been most successfully cultivated at Coimbatore.

As for any economy to be derived from an improved method of *cleaning* the Cotton, or separating it from the seed, it may do something, but not much. At Coimbatore, in the Malabar country, Cotton is now cleaned by saw-gins worked by manual labour at the rate of ten annas, or fifteenpence, for 500lbs. or $33\frac{1}{3}$lbs. for *one* penny; and by the common native churka, the cost of separating the fibre from the seed is at the rate of 28lbs. for one anna, or $18\frac{1}{2}$lbs. for one penny, which is at the rate of $1\frac{3}{4}$rs., or 3*s.* 6*d.* per candy of 7 cwt. or 14 annas per bale, which at 93 rupees per candy is not *one-fiftieth* the total cost of the Cotton, so that supposing that by an improved method, the expense of cleaning Cotton was reduced one-half, it would not cause a difference of *one rupee* in the price of Cotton per candy, less than the common fluctuations in the market.

The native churka for cleaning Cotton differs in form in different parts of the country,—that described and figured not long ago in the Bombay *Telegraph and Courier*, is said to consist of two cylinders revolving close together, the upper one being of iron about twelve inches between the supports, and three quarters an inch in diameter, made to revolve very rapidly by means of a heavy fly-wheel turned by an assistant. The other roller being of hard wood about two inches in diameter, and turned slowly in a contrary direction to the iron roller by the Cotton-cleaner, who turns the roller with one hand, and at the same time supplies the Cotton to the rollers with the other. By this machine it is stated that from twenty to forty pounds of clean wool can in this way be produced daily by two individuals. This is rather a wide margin of average with which to compare the results from any other churka, but if the average is taken it will be thirty, or fifteen pounds for each person.

The churka in use in the Coimbatore districts in Malabar differs very materially from the foregoing, it consists of two smooth wooden rollers ten inches long between the bearings, by about $\frac{7}{8}$ths of an inch in diameter. The machine is worked by one person, who turns a handle attached to the lower roller, giving motion to the upper cylinder by means of an endless screw cut in the ends of each cylinder, which engaging one another causes them to revolve in a contrary direction. With the other hand, the Cotton-cleaner supplies the Cotton to the rollers,—with this simple machine one person will clean 28lbs. of Cotton per day at a cost of one *anna*.

The author of this paper made a churka on this principle, the rollers of which are twenty inches between the supports, and barely $1\frac{1}{4}$ inch in diameter; a heavy fly-wheel, two feet eleven inches in diameter, is attached to the lower roller, this is made to revolve rapidly by an assistant, so that the Cotton-cleaner can use *both* hands in supplying the Cotton to rollers double the usual length,—both parties sit on the ground, a position, the most agreeable to natives. With this machine in good order, nearly double the amount of Cotton can be cleaned,—that is, *two* persons could clean as much as *four* at the single churkas would turn out. The machine in question acted very well at first, but the rollers having been made of unseasoned wood, the only kind at the time obtainable, they warped slightly, when the rains set in, which allowed some of the seeds to pass through the rollers, but sufficient was done to draw an admission from the natives of the advantages the fly-wheel gave to this churka over theirs, as also the benefit derived from one person turning the rollers, and the other feeding them with *both* hands, enabling a much quicker motion to be applied, and moreover by changing alternately from turning the handle to supplying the Cotton there was less fatigue.

There has been great difference of opinion as to the

applicability of the American saw-gin for cleaning Indian Cotton. Cotton may be divided into two chief classes, that having a smooth black seed, such as the Sea-Island, Bourbon, Egyptian Cotton, and that having a seed covered with a *fur* after the fibre has been drawn off, such as the New Orleans, Upland American, and all Indian Cotton. In the smooth seed variety, the churka is decidedly the best adapted and most efficient machine; but for the *furry* seed, from which it is more difficult to detach the Cotton fibre, the saw-gin answers best; on this principle, the saw-gin ought to be applied to the Indian Cotton: but, in so doing, the gins must be adapted to the smallness of the seeds and shortness of the fibre of the Indian plant. Now the seed of the Indian Cotton, as grown at Coimbatore, weighs only, when cleaned, three-quarters of a grain, whereas the cleaned seed of the New Orleans variety, weighs very nearly *one and a half* grains, or is double the size of the Indian seed. The saws, therefore, require to be made much finer, having twelve or fourteen teeth to the inch, instead of eight teeth, and the bars must be placed much closer, so as to prevent the seeds being drawn through them, which was probably not attended to on the first trials at Surat, when the saw-gins were said to fail. One advantage of the churka is, that it gives employment to the women, the old, and the decrepit, and to children, who look to this occupation for their support; but in a purely mercantile view, it is believed that the saw-gin will be found to clean even Indian Cotton at a lower rate than can ever be performed by any description of churka; but the saving effected, under any circumstances, will scarcely amount to the fluctuations of the price of Cotton in the market, dependent upon circumstances over which the grower has no control.

It must, then, be to the culture, to the producing a *larger quantity of superior Cotton,* from the *same area* of land, to which we must look for being enabled

much longer to compete with America in supplying the English market with Cotton.

Should the proposition for increasing the supply from a certain area of surface, by means of irrigation and drainage, be looked upon as visionary or crude, though the writer believes it to be well deserving of attention, there can be no doubt of the desirableness of endeavouring to land the supply of our best and most productive Cotton districts, in the English markets, at a cost that shall, notwithstanding the American competition, still be remunerative; and if the culture of Cotton is considered incapable of improvement, which is, however, by no means admitted, the means of transit to the shipping ports, and of shipment, may, there can be no doubt, be improved. Should the Indian Government not feel themselves called upon, or be inclined to do this, there seems no reason why the Great Indian Peninsular Railway Company should not have its Act of Parliament so extended, as to admit of its embracing such contingencies, within the limits of its operations, or should limit its undertakings to merely constructing a railway for locomotive steam-carriages into the interior of the Peninsula; or why it should not comprise the *general* improvement of the means of transit of the products of India. If lines of iron tram-rails, to be worked by cattle, were so laid down as to convey the Guzrat Cotton to its shipping ports; if at those ports, wharves, or piers, were constructed, so as to facilitate the shipment of the Cotton, much or, at all events, something might be done for the improvement of the Cotton trade; and a very trifling tollage, much less than that which the present system of carriage to the port and shipment now costs, would, in all probability, well repay the speculation. Such a proceeding would, moreover, disseminate, not merely in the line of the Grand Railway, but throughout the country, the advantages even in a pecuniary point of view, of which the native is most susceptible, by

the introduction of Science and the Arts, as assistants and promoters of the agricultural interests of a country.*

* When these remarks were written, the Author was unaware of what was at the very time being done in Guzrat by Captain P. T. French, Acting Resident at Baroda, and by Captain Fulljames, Commanding the Guzrat Irregular Horse, who have forestalled him in actually making an attempt to carry into effect what is above advocated, so that before these pages issue from the press, it is hoped that the surveyor will already be on the line between Tankaria Bunder and Baroda.

CHAPTER II.

ALTHOUGH, therefore, the writer believes that too much stress has been laid upon the improvement our Cotton trade will experience from the construction of the Great Indian Peninsular Railway, there can be, in his opinion, no doubt, not only, that this Railway will find ample work to perform, but also that it will confer a great benefit on the country, by showing how much may be gained—actually gained in money—by the application of the Arts to Agriculture and Commerce. When it has been once practically proved that heavy and bulky goods can be conveyed through a district, both expeditiously and economically, by the scientific arrangements of a Railway, neither Government nor the natives will long remain content with the cart-tracks, which now form, in many parts of this Presidency, the only means of communication through the districts, as in Guzrat, there is not a single made road, but will gradually be led to believe that money expended on an improved system of transit is really and practically a great saving in the end; and this knowledge once learned, they will begin to find that the construction of piers, wharves, and conveniences for loading and unloading vessels, is also money well expended, so that we may hope that the wholesome principle of the application of Science to the internal improvement of a country, having once been introduced into the system, will soon circulate through every vein and artery, and in time produce a more healthy tone of the whole economy of the State. But to have this beneficial effect, the first Railways

must be so constructed, as *to pay* as a commercial speculation — a truth that cannot be too frequently, or too strongly, promulgated; to do which, they must be executed in the most economical manner. Such economy, not consisting in what is generally understood by *cheap works*, for every part should be of the *very best* of its kind, but by adopting such a system of general construction and working of the line, as experience has shown to be the most efficient and profitable in the long run.

Railroads, on their first introduction into England, had a great deal to fight against. The turnpike-roads had then arrived at a state of great excellence; the mails, and other stage-coaches, had attained a speed, owing to the goodness of the roads, previously unknown; long habit had accustomed the population to this mode of conveyance, of which they were justly proud, as being the finest of its kind in Europe; great interests, both landed and commercial, were intimately connected with the long established King's Highways, so that the time appeared most unpropitious for the adoption of any new mode of transit, and those interested in the success of the novel scheme, were obliged to employ every means in their power to draw attention to their undertaking.

Among the measures thus resorted to, was that of constructing all their buildings, and works connected with the enterprise, on a scale of grandeur and magnificence hitherto unknown in purely commercial operations. Witness the triumphal arch entrance to the London and Birmingham Railway, at Euston-square, which appeared at the time more suitable as the entrance to a palace, than to the yard of a Transit Company.

In all their works and undertakings, money appeared no object; the Directors of the Companies had the control of a capital which was reckoned by millions, and which appeared inexhaustible, and their policy appears to have been to astonish the public by the grand scale of

their operations, and thus to force applause and approval, if not to the principle of their new system of transit, at all events to the magnificent manner in which that principle was being carried out. These views, together with the emulation and competition between the several Railway Companies, caused a lavish expenditure, and a system of construction regardless of cost, that, without increasing the real efficiency of the works, has sunk such an enormous amount of capital, as seriously to affect them as profitable undertakings.

But there can be no reason why, in introducing Railroads into this country, a similar fatal principle to the welfare of the speculation should be followed. Here we have no rival modes of transit to compete with, nothing to *undo*, and there can be no necessity for that *ad captandum* mode of proceeding which was probably necessary to secure the introduction of Railways into England. Everything connected with such works in this country should be of the plainest, at the same time, of the most substantial description; and whilst taking advantage of all that the skill and energy of our English Engineers has developed in Railway locomotion, we should as carefully avoid those errors (some of them probably necessary in England) that experience has now shown, and is daily exemplifying to be, all but fatal to many lines of Railway as a profitable transaction.

The following observations made by Mr. W. Harding, in a paper on Railway Statistics, read before the British Association, in August 1848, are so much to the point, that the author is induced to transcribe them: —"The great evil of the last three years is the extravagant outlay of money which has taken place, an outlay which, instead of being checked by the legislature, has been encouraged to the utmost by the mode of inquiry adopted. This has inflicted on the Railway system a burthen which it will never be able to throw off, and which the public will always have to bear with

them, in a higher rate of charge for conveyance, than would with common prudence have been necessary. It only remains to stop this extravagance with a high hand ; the very existence of the Companies depends upon the economy they can practise in making and working their Railways, and nothing which on the face of it involves increased outlay, should be countenanced, if we wish to secure for ourselves this admirable invention."

India being a country of extremes, with vast plains, high and precipitous mountain ridges, broad rivers, down which, at certain seasons of the year, flow vast volumes of water with great rapidity; a line of Railway, instead of passing over the undulating country presenting numerous small obstacles, almost at every yard, as in England, will, for miles, traverse a plain requiring little more than the mere superficial construction of the permanent way, entailing a very trifling expenditure, and will then arrive at a range of hills, or a river, to ascend or cross which, will nearly swamp the whole available capital, as it *can* be shown that to cross the Soane River of two miles and three furlongs in breadth, would entail upon the Bengal Railway an expenditure of nearly 400,000*l.* for a double line of rails, or two-thirds that amount for a single line, or *half* the whole sum, for which a guarantee of 5*l.* per cent. has been allowed; and that the excavation of the tunnels on the Bombay line between Bombay and the top of the Malsej Ghaut would, for a double line, at the average actual cost of tunnelling in England of 64*l.* per lineal yard, amount to nearly 500,000*l.*, on the *whole* amount of which a guarantee has been allowed, and for the *one* tunnel between Bombay and Callian, the cost would be nearly one-fifth of that sum, especially if, as is most likely the case, it has to be blasted through basalt.* Every endeavour should, therefore, be made in laying down the lines of the first Railroads,

* Appendix C.

to avoid such extreme expenditures on particular points, as those above enumerated; it would be far better, where it can be managed, to make a *detour*, and rather turn the hills, than go through or over them, as the expense of a few extra miles of Railway on a plain, or across easy ground, will bear no proportion to that of overcoming these extreme obstacles. Where very large and broad rivers occur, it will be better to cross them, at first, by light foot-bridges, than to endeavour to run the trains across them, at an expense which will swallow up all the available capital; the transit of goods and passengers will be so unprecedentedly rapid, and the little time occupied in moving from one place to another, so astonishing to those accustomed to the dilatory mode of travelling in India; that the trifling delays thus occasioned, would not be noticed in the extreme delight and wonder at the general quickness of the transit.

The object then should be, to make the first Railway encounter as few difficulties, and by difficulties is meant *expensive* operations, as possible; that the works should be good, the embankments solid and firm; the bridges substantial and durable; the permanent way, well and carefully laid down; the gradients moderate, and the curves tolerably easy; but that all *extreme obstacles* should be for the present avoided, so as not, by endeavouring to overcome them, ruin the whole affair as a paying speculation. When once by thus constructing a good and efficient line, at a moderate expense, it has been completed, and is being worked, not only not at a loss, but with a profit, even independent of the guarantee allowed for a certain time by the Government, and having thus once established itself as a profitable investment, then by means of a Reserved Fund, established from the first, or by an increase of capital, the great obstacles may be attacked, and gradually vanquished, without any fear of injuring the undertaking, and the whole line thus brought by

degrees to that state of perfection, which, if attempted at first, will, undoubtedly, it is feared, tend to mar its whole prospects of success.

But if we wait for the line between even Bombay and Callian, or to the foot of the Malsej Ghaut, to be completed, and to be tested as to its being a profitable enterprise, before anything more is tried, years of most valuable time will be lost. If the thing is attempted at all it should be entered into heart and mind, and the first portion made complete and of real use in itself, and there will be no want of capitalists coming forward to the support of the undertaking; for the apathy with which the proposal of a Railway has been received has arisen greatly, from the chimerical nature of all new or great undertakings in India. We have for so many years *heard* of Grand Canals being excavated, of Great Trunk Lines of Road being constructed, of Rivers being dammed, of Lands being irrigated, and, after years of preparation, surveying, planning, estimating, referring, and eventual sanction, seen all the bright visions fade away at the sound of the trumpet of war, that we have almost ceased to believe that any new project will *really* be carried into execution; but that it will, after a deal of talking and writing, share the fate of all similar propositions; but let the Railway once possess a *reality*, let the natives see that *this time* we are at all events in *earnest*, that it possesses an innate vigour and energy hitherto unknown, except by report, and there will, it is confidently believed, be no fear of its not meeting with all the support, even from the native community, that can even be desired.

One of the errors into which the English Railway engineers have gradually fallen has been the introduction of the monster locomotive engines, which now traverse with their unwieldy bulk and weight, lines of rails that were never intended for the transit of such masses, and which, introduced into this country, as the perfection of

English locomotives, would necessitate a description of work, and an expense of construction and of working the line, that *must*, with the traffic that India can ever provide, prove fatal to the general adoption of Railways as a means of transit in India.

When it was first proposed to run steam-locomotives on the Railways in England, the weight of the engines, with water in the boiler, was limited to six tons; and so strictly was this adhered to that one of the engines which competed for the prize of 500*l*., given by the Directors of the Liverpool and Manchester Railway, was thrown out of the competition, because it weighed more than the above trifling load. As the traffic on the lines increased, however, it was found absolutely necessary to provide more powerful engines; and as, in building each new carriage, some improvement was made in its construction, so did its speed increase; for the speed of an engine depends upon the degree of rapidity with which the water can be converted into steam of the required elasticity, hence the speed is increased by increasing the surface of the boiler exposed to the fire, and by increasing the draft of the furnace (see "Whewell's Mechanics of Engineering)." It was to the introduction of the tubular boilers and other improvements in the details of the engine that the accelerated speed ought really to be attributed; but as, owing to the constantly increasing traffic, more powerful engines were required, each new and improved engine was made larger, and, consequently, heavier than its predecessors, the speed of these improved engines was therefore attributed either to the additional weight of the engine, or it was supposed that this great increase of weight in the engine was absolutely necessary to admit of the speed being accelerated; whereas it was merely a casual coincidence that the improvements in the construction of the engines and of the vastly increased power of converting the water into steam, possessed by the tubular boilers, should have

gone hand in hand with the necessity (owing to the additional traffic) of increasing the power, and consequently the size and also the *weight* of the engine.

From these causes an idea gradually gained ground that "weight was speed," and as speed still continued, especially for express and mail trains, to be an objeet of great importance, so the *weight* of the engines was continually augmented, from an idea that such was absolutely necessary to admit of additional speed, until, from engines of *six tons* they have gradually advanced to ten, sixteen, thirty, and, it is said, even to thirty-five and forty tons, the speed increasing from twenty to fifty miles an hour; but the strength of the rails on which the present monster engines run has by no means kept pace with the weight of the engines. The original rails on the Manchester and Liverpool line were thirty-five pounds to the lineal yard, with bearings of three feet. These rails have now been raised to sixty and eighty pounds a yard, giving a *stiffness*, or resistance, to deflexion, however, by no means proportional to the momentum of the heavy engines.

The consequence of this great increase in the weight of the locomotive engines has been to wear and tear the rails to such an extent that, whereas it was a few years ago supposed, or rather asserted, from experiment and calculation, that railway bars would last for thirty years, it is *now* stated that they require to be re-laid every *eight* years where the traffic is great, and where exposed to the effects of these monster engines, or that the rails will now last only about *one-fourth* the time it was formerly supposed they would.

The wear and tear of Railway bars is produced in two ways,—one, by the wearing away of the upper surface of the rail by the friction of the wheels of the carriages and engines, which is nearly proportional to the weight of the engine; and the other, by the loosening of the joints and chairs, and consequent derangement of that perfect uniformity of level and direction in

the rails which is so absolutely necessary to preserve them from being destroyed by the immense weights, moving at great velocities, which pass over them, and if there is not an exact uniformity of resistance and strength in every part of the rail, an unequal amount of action is generated, tending greatly to derange and destroy them.

There can be no doubt but that the wear and tear of the rails, from a very heavy engine, will be much greater, even in proportion to its power of drawing a train, than that of a lighter engine; for the heavier the engine the greater the momentum with which it strikes or impinges upon the rails, and consequently the greater their deflexion, which, as they are not strained beyond their *elastic* force, causes them to act as a series of springs; and the greater the momentum the greater this springing action, and the greater the effect upon all the carriages drawn by the engine, which are thus more or less acted upon, as the engine drawing them is heavier or lighter: these succeeding carriages, thus passing over a perpetual wave, which each carriage, in its turn, helps to increase, tending not only to augment the amount of traction from their wheels constantly ascending an inclined plane formed by these waving lines; but in a long train of carriages, as the undulation of each carriage is separate and distinct, the rear of one descending as the front of the succeeding carriage may be ascending, the resistance to traction is greatly increased by this want of *uniformity* of *impulse* throughout the load, which must tell, with very great force, in ascending steep gradients. Indeed, it would appear, from a paper read before the Society of Mechanical Engineers, in April, 1849, that the metal of the rails is now supposed to be actually, to a certain extent, crushed by the extreme pressure of the wheels of these monster engines, which caused a remark, " that it looked as if they had almost reached the limit of their powers, when they began to crush the

material." This crushing is supposed to occur with driving wheels loaded with a weight of six tons, so that one cannot be surprised at the rapid deterioration of the rails and permanent way over which a load of six tons, acting on only three quarters of a square inch of surface, is made to run at the rate of forty or fifty miles an hour.

It would also be advisable, as far as can be managed, that the engines should not be heavier, length for length, or bear a greater weight on each wheel, than the carriages which they draw, whereas with the present heavy engines reckoned to weigh one ton per foot lineal, whilst the heaviest loaded carriages are only calculated at *half a ton* per foot, the pressure of the engine upon the rail is double that of the carriages, which must be false economy; for a rail of strength proportionate to carry the heavy engine is unnecessarily strong, or has a waste of iron for the load of the train; or, if made proportionate to the train, is not strong or stiff enough for the strain due to the engine. Another obvious point to be attended to, in regulating the weight of a locomotive engine, is that it should bear as small a proportion to its power as is compatible with strength and durability; but it has lately been asserted, that in many of the Branch Lines on the English Railways, not less than eighteen to twenty tons weight of engine, or power, is employed to convey *one* ton of passengers, or load; this must be wrong, as $\frac{18}{20}$ths of the power is thus employed in *moving itself*, which is similar to attempting to make an elephant gallop.

This great excess of weight in these monster engines has, as before stated, arisen from an erroneous belief, inculcated by the casual coincidence of the improvement in the speed of the engines, with their increase in weight, which was consequently considered as absolutely necessary to keep an engine on the rails at great speed, forgetting, apparently, that the greater the weight, and consequently the momentum of the engine, the

greater the springing action of the rails; but this idea has now been practically shown to be a mistaken notion by Mr. Samuel, of the Eastern Counties Railway, who has had constructed for himself a locomotive carriage and engine, weighing only 25 cwt., including coke and water, and attaining a rate of forty-four miles an hour, with a greater steadiness at maximum speed than a first class carriage. This little engine had tubular boilers, giving a large amount of heating surface, and nothing can more completely show, that the increased speed of locomotives has been brought about by an improved construction of the details of the engines, and particularly by a greater capability of rapidly converting water into vapour of the required degree of elasticity than this experiment, or that *great weight* is by no means absolutely necessary to keep an engine on the rails at a high rate of speed.

In addition to this little engine, another larger steam carriage, on a similar principle, has been constructed under Mr. Samuel's directions, which, with its attached carriage, with coke and water, weighed altogether about ten tons, with about three tons pressure on each driving-wheel. This carriage is capable of containing forty-eight passengers, and on its first trial in November, 1848, when every thing was stiff, maintained a speed of twenty-four miles an hour, up an incline of 1 in 100, and forty-one miles per hour down the same incline.

Mr. Samuel, in his paper on his new carriage engines, read before the Institution of Mechanical Engineers, in June, 1848, observes, " The average weight of a train on the branch lines of the leading Railways is fifty-six tons — the number of passengers conveyed by each train, not exceeding thirty-five to forty on many of the Branch Railways in England. Supposing " each passenger with luggage to weigh $1\frac{1}{2}$ cwt. the total weight of passengers conveyed is about three tons; or, in other words, for *every ton* of *paying load*, we are now carrying by the present system of locomotion, we have from

eighteen to twenty tons of *dead weight*," whereas it is evident that the greater the proportion the *paying* load bears to the weight of the engine or non-paying dead weight, the greater must be the profit of the line. Mr. Samuel adds, "That were the system of light steam carriages adopted, Branch Railways might be constructed at a very small cost indeed, compared with the present outlay (which is unavoidable so long as the present system of heavy engines is continued) and the advantages of Railway accommodation might be extended to those districts, which can never hope to enjoy them, if the construction of Railways continue to require such large outlays of capital;" and although this engine had been expressly constructed for the conveyance of passengers, Mr. Samuel stated, "That he was prepared to work the goods traffic in a similar manner."

For the conveyance of passengers by rail in India, the carriage engines of Mr. Samuel appear peculiarly adapted, and it is also said that they can, by lessening the speed, be used for goods traffic, drawing a light carriage behind them: or, at all events, steam locomotives of light weight, say ten or twelve tons, would answer every purpose. The advantages of Mr. Samuel's locomotive carriage engines are, that they are comparatively safe, from the centre of gravity of the carriage being so low down; and from the facility with which they can be brought to a stand-still, and the comparatively short distance required to effect this purpose; an object of the utmost importance in India, especially on the first lines of rails, where from ignorance of the consequences, from habitual carelessness, and other causes, obstructions will very probably be found on the rails unless the viaduct system be adopted, requiring a description of engine to be employed, much more under command than the monster engines now in use in England: and, moreover, for the conveyance of passengers, certainly, if not for goods, Mr. Samuel's steam carriages convey a far greater proportion of load to the

weight of the moving power, than any locomotive engine. Such a steam carriage as previously described, weighing only ten tons, or thirteen tons when loaded with forty passengers, would not, for the length of which it must be made, weigh more than *one-third* of a ton per foot lineal, instead of *one* ton the weight allowed for the heavy locomotives, so that for a single line, supposing one of Mr. Samuel's engines to be introduced on our Indian Railways, the bridges, viaducts, permanent way, rails, &c., if constructed for a load of *half a ton* a foot lineal for a single line, would be sufficient to meet all contingencies of the traffic in the districts; in fact, so great would be the difference of cost, especially if the system of bridging and viaducts now proposed were introduced, in connection with these steam carriages, that it is believed a double line might be constructed and maintained at a very trifling excess of expense over what would be incurred on a single line for the heavy locomotives now in use in England, and the great advantages of a light double line over a single heavy one cannot be doubted.

Of the capabilities of these steam carriages, and of the very small expense at which they can be laid upon a line, an idea may be formed from the following extract from the "Civil Engineers and Architects' Journal" for December 1847—alluding to the steam carriage that was subsequently built and tried on Mr. Samuel's principle—"We have now before us a practical tender from persons fully competent to carry the plan into action, to furnish steam carriages, rails, and timber work, ready for use, provided the land be delivered, levelled, and ballasted, ready for the permanent way, at the price of 2,000*l.* per mile of single way, the carriage to travel fifty miles an hour, and to carry 1000 persons per day of twelve hours, over a line twenty miles in length, with greater safety than with the present engine." In November, 1848, the first engine of the class here alluded to, was tried, and is that before described, as

having, when everything was stiff, performed twenty-four miles an hour, up an incline of one in 100, and forty-one miles an hour down the same incline. Should there be any doubt as to the real qualities of these small light engines, it ought to be removed by the general opinion expressed regarding them at a meeting of the Society of Mechanical Engineers in London, in July 1848, of their entire approval of the engine for all purposes of the ordinary branch line of railways, which must be a sufficient guarantee of their practical merits.

In the same article in the "Engineers and Architects' Journal," a proposition is made for applying Mr. Samuel's steam carriages, as an extra transit on the present lines, by constructing lines of rails on each side of embankments, &c., sufficiently strong and firm to carry these light engines, and it would be worth while to consider how far the project of running a small steam carriage similar to Mr. Samuel's first construction, might be applicable to India. This little carriage, with its coke and water, weighing only 25 cwt., expending only $2\frac{1}{2}$ lbs. of coke per mile—and in England, the total expense for drivers, coke, and oil, being *only one penny per mile*—and carrying seven passengers, besides the driver, at a rate of upwards of forty miles an hour, ascending steep gradients, *and with the power of bringing up from speed in about fifty yards*, appears peculiarly suited for an *express train* on our Bombay line; such an engine *might* reach Delhi, with the mail in thirty-six hours, instead of eight or ten days, its present time of transit; or if travelling only by daylight, *three* days would be sufficient time to reach Delhi with passengers and the mail; so that there could be no doubt of this mode of conveyance being taken advantage of by all officers, and others, proceeding to, or returning from England, from the north-west provinces; whilst the actual cost of thus carrying seven passengers and the mail, all the way from Bombay to Delhi, would, at the English rate of one penny per mile, amount to only 3*l.* 12*s.*; or say that this cost is increased

three or four-fold, and it would pay even for the conveyance of the daily dawk, not to mention the profit from the constant passenger traffic.

Not only would the mail, passengers and light articles of value, thus be conveyed to the Punjaub and to the north-west provinces, but in time, Bombay would become the line of transit also, from England to Calcutta, and Madras. To Calcutta is 1185 miles, a distance at thirty miles an hour for thirteen hours of daylight, *capable* of being accomplished in *three days;* to Madras from Bombay is 763 miles, or *two days'* journey at the same rate; compare these times with the length of voyage from Aden to either of these places, and see the advantages Bombay would possess for the conveyance of the mails and passengers, and all such articles as are usually brought by the overland route. These are no ideal advantages, they are matters of fact and calculation. Whether an express line of the light rails and construction, capable of carrying the small light express engines now under notice, would pay—and pay better than any other description of Railway in India, let the above facts show. Nor would it be to the capitals of the other Presidencies alone that the transit would be profitable, but to all the stations on the road; and Bombay would then become, as it ought to be, with Suez where it is, the great focus of inland communication with England from *all* parts of India. The writer is not quite sanguine enough to suppose, that the construction of nearly 3000 miles of Railway could be undertaken at once, but the above remarks are sufficient to show what might be done for India by a comprehensive system of Railways; and which, if adopted for light engines and light trains, might be completed at a practicable cost.

The smallness, the cheapness, and the astounding low rate of working such a little engine for the express mail, as has now been proposed, may cause it to be looked upon as a toy; be it so—a toy that could carry the mail

from Bombay to Delhi in thirty-six hours on an emergency, or, travelling only by daylight, convey passengers in three days, would be the prettiest and most favourite toy we have ever seen in India; *indeed, do we want at present for passenger-traffic more than this toy?* Seven passengers, or, by the larger engine-carriage of the same class, forty or fifty passengers, travelling thirty or forty miles an hour, might leave Bombay every hour, if necessary. Professor Barlow states, that on the Grand Junction Railway at Kensal Green, the locomotives and trains pass *seventy times* a day, so that there could be no fear of passengers, at least such as would travel by an express train, not finding accommodation; and if we are not likely for the present to require greater means of passenger-traffic than such carriage-engines would supply, why should we have more? But if English science and skill have enabled passengers to be thus conveyed at so small an outlay, at such a speed, why should we hesitate to take advantage of it? The grand principle of Nature, and of mechanics, is to adapt the power to the work to be performed; depend upon it, the little express engine would be the most favoured child of the Railway, if not the most profitable, whilst it would ensure to Bombay the advantages its geographical position has long given it, of being the passenger shipping port for England of the north-west provinces, the Punjaub, and the greater portion of Hindoostan.

But without presuming to offer more than an opinion upon the peculiar merits of Mr. Samuel's carriage-engines, and their applicability for the passenger-traffic, and probably for the goods-traffic, on the branch lines in the districts of this country, enough has, it is conceived, been adduced to establish the assertion of the advantage of running numerous light trains to fewer heavy trains, as well as to show that even to ensure great speed, a great weight of engine is by no means an absolute necessity.

This principle of running numerous light trains, has many and important advantages, the same amount of load may be conveyed in the same time as by fewer heavy trains, and with much less wear and tear of the line. There is less chance of embankments failing from an overburthened load on them,—a point of considerable importance in India, where, for four months of the year, these embankments will be flooded with water, being subjected during that period to the effects of from eighty to 100 inches of rain in Bombay and below the Ghauts. All bridges and viaducts may be constructed of timber or iron, or the two combined, as proposed in this treatise, at a cheaper rate than is necessary for the very heavy engines now in use; whilst the rails and general construction of the permanent way, may be made much less costly; the several stations and depôts, which need not be increased in number, may be smaller in dimensions for a system of light trains departing at short intervals, than where large trains bring an accumulation of passengers, or goods; the same number of *employés*, or establishments, with the sole exception of engine-drivers, will suffice, whether the trains run frequently during the day or seldom; whilst a smaller number of porters are required to load and attend to light trains than to heavy ones, the same guards of the line, the same signal-men, overseers, &c., will equally answer in the one case as in the other, and therefore, whilst the use of large heavy engines would entail a much greater cost of original construction, a greater expense of working the line, and a much greater wear and tear of the rails, they would possess no corresponding advantages.

Mr. Chapman, in his report on the Great Indian Peninsular Railway, which is only projected as a single line, reckons upon 180,000 tons of goods-traffic per annum, of which 84,530 tons are the present exports and imports to and from the Concan, and 80,000 tons the supposed amount of salt that will be carried to the

interior by the Rail; but of the imports and exports from the Concan, those from *Panwell* are included, which amount to seven-sixteenths of the whole traffic, but very little of which will ever find its way to the proposed Rail by the Malsej Ghaut, as will be hereafter shown. 55,761 tons of grain are also included in the imports to Bombay from the Concan by this line, which is the total probable amount of grain consumed in Bombay, supposing there to be 300,000 inhabitants, and each man to eat $1\frac{1}{3}$lbs. of grain per diem; thus, then, this Railway is supposed to bring the whole of the grain consumed in Bombay, with the exception of that required for the horses, which, when the great proportion of rice eaten in Bombay is considered, which will not come by rail, is apparently much over-estimated; and a considerable portion of the salt consumption, or all that now goes by the Bhore Ghaut, will not travel by the Malsej line. Though, therefore, it is probable that the traffic on this line will not for a long period reach the 180,000 tons calculated for, still it will be very great, and more than can be conveyed by *a single* line of rail, unless very large and heavy engines are used, as 180,000 tons is 600 tons per day for 300 working days, which is much more than is now carried by many English Railways; as in England, in 1847, out of sixty-three Railways, only twenty-four carried more, or so much, as 180,000 tons of goods per annum. The Eastern Counties, Cambridge, carried 236,463 tons, and the Eastern Counties of Norfolk, 118,096 tons; the Great Western carried 374,326 tons, or only double the estimated traffic on the Bombay line. The London and Brighton carried only 156,930 tons; the London and South-Western, 148,615; and the South-Eastern, 204,102. True, these are only the amounts of the goods-traffic, whereas the chief transit of the English trains is that of passengers. In England, in 1847, the revenue derived from passengers was as near as possible double that derived from the carriage of goods, whilst

each passenger pays about the rate per mile of half a ton of goods; and if this is applied to the above returns, the difficulty of conveying 180,000 tons of goods per annum on a single line will be seen. The trains in England run during the night as well as in the day, a practice that cannot for many years to come be attempted in India. Everything is in the most perfect order and training, and the whole business is conducted with the utmost regularity, arrangement and economical expenditure of time.

To carry 180,000 tons of goods on a single line, then, large heavy engines and trains must be adopted, which, as above shown, are not suitable to Indian Railways, and, if introduced, will produce the same ruin to the profitable nature of the undertaking as they have in England; in fact, single lines are not adapted for much traffic; the delays on them are great; they require the greatest caution for the prevention of accidents, the greatest regularity in working the trains to be at all efficient, and when the line gets out of order, the whole traffic must be stopped until it is repaired; whereas, by employing a double line calculated for light engines and trains, a much greater quantity of goods can be carried during the day, as any number of trains may succeed each other; the wear and tear of the permanent way and rails will be incomparably less than when heavy engines are used, the engines will be more under command, and capable of being brought to a state of rest in a shorter space,—a point that cannot be too often and too strongly insisted upon as absolutely necessary in India, which, from every reason, is totally unsuited for the transit of the huge unmanageable engines and trains now running on the English lines.

Indeed, for India, so absolutely necessary is this power of having the engines under control, that it would be better to have a double line for ordinary heavy goods, and a small intermediate line, calculated to carry such light engines as those designed by Mr. Samuel for pas-

senger-traffic and for the conveyance of the light and valuable parcels, such as come out from England overland, which could travel at a much greater speed than is either necessary or desirable for the goods-trains without interfering with them; and from their capability of being stopped in a very short space, it is said within fifty yards, they are admirably suited for passenger-carriages.

In England, where the value of land is so great, an embankment wide enough for three lines might appear out of the question; but in India this is no objection, and as the expense of a single line is always calculated at *two-thirds* that of a double line, it is probable that a line of three rails would not cost more than one-fourth more than a double line, or certainly that three lines calculated for light engines would not entail so great an outlay as a double line suited to the heavy engines now in use in England. Another great advantage of a double line in the first introduction of Railways into India, is that when one line gets out of repair, or the rails require repacking or replacing, that the traffic on the other line need not be stopped; and at first it is much to be expected that, owing to the settling of the embankments, or other causes, the rails will frequently get out of order, tendiug much to disparage the advantages of railway communication in India, were the natives to find the transit by this new mode frequently altogether suspended, which would not be the case with a double line.

Whether or not, therefore, Mr. Samuel's carriage-engines may be considered applicable to Indian Railways—though the author believes that they will be found to be so for passenger-traffic, and for goods-traffic on the Branch Lines—the desirableness of constructing the Railways in India for the transit of light engines and light trains has, it is believed, been established.

Another advantage of using light engines and trains is, that in those seasons of the year, when the traffic is

considerable, a greater number of engines may be put on the line to meet the demand of traffic, whilst when it is trifling, which it will be at certain periods, it will evidently be more economical to employ one small engine than one large one, which will apply also to the first opening of the line before the traffic has become general, so that the expense of working the line can be kept more in proportion to the varying amount of the load; a point of great importance in India, where the expense of *fuel* will be so much greater than it is in England, which causes also an additional necessity for proportioning the power to the load as nearly as possible; for the waste of fuel in driving an engine and train weighing fifty-six tons to carry forty or fifty passengers, who can be equally, quickly, and safely conveyed with an expenditure of fuel required for a steam-carriage of only ten tons, must be such as could not be permitted, where fuel will be so expensive an item of the transit as it will be on the Bombay line.

In the pamphlet entitled "Railways for Bombay," it is stated, "That the Cotton of Berar does not appear in the local market much before February, and as it is not all cleaned and prepared before April, it requires the utmost exertion to bring any portion of it to Bombay previous to the setting in of the south-west monsoon; while it almost invariably happens that large quantities are caught on the road by the rain, and, if not destroyed, are greatly damaged by becoming wet, mouldy, and black." It might at first sight appear from this extract, that as there exists such a necessity for hurrying the Cotton from Berar, and the inland districts down to Bombay, all at once as it were, that the demand for traffic on the Railways will, at such seasons, be so great as to necessitate the employment of heavy trains; but as Cotton carried on Railway carriages can be perfectly secured from wet, and as there is no other immediate necessity for the Cotton arriving

at Bombay previous to the setting in of the monsoon, it is evident, that the simultaneousness of despatch will not in such case be necessary, as Cotton is shipped from Bombay at all seasons of the year—the chief supply to China leaving Bombay during the monsoon months. In 1846, 142,606 bales of Cotton were exported from Bombay to China, of which the greatest number were shipped in June, July, August, and September, whilst by far the greatest number of bales shipped for England, in the same year were in November, so that the inland Cotton may continue to arrive, and to be shipped during all those months, and thus be brought gradually to Bombay, for which a system of light engines and trains will afford ample transit, instead of being necessitated to arrive before a certain date as at present.

In a pamphlet very recently published at Calcutta, a system of iron-bar tram-line, to be worked by cattle, has been advocated, as being more suited to the nature of the traffic required for India than the steam locomotive system. The writer proposes a single track, the rails to be laid on a continued series of longitudinal wooden sleepers, which again are supported on transverse wooden sleepers, these last resting on a metalling of broken stones, or brick-kiln or smithy clinkins rammed into trenches eighteen inches deep, cut across the line of road, at distances of every five feet, the under formation of the road not being considered, the proposal being to run the projected lines along other roads, or on old roads. It is proposed to work this line, in the first instance, by hired cattle; but steam locomotives may be used on the line where necessary. The estimated cost of laying down such a line of bar-rails, which are to be $2\frac{1}{2}$ inches wide by $\frac{5}{8}$ths thick, is about 6000 rs., or 600*l*. per mile.

In comparing the advantages of this description of Railway with those in England, the present heavy locomotive engines have been considered as costing 3000*l*. each, and as requiring a weight of fifty-seven tons of

machinery and carriages, to convey passengers and baggage weighing nine tons only.

It is not here intended to enter into any minute examination of the merits of this system, as it is probable that different application of the Railway principle of transit may be found to be required for each Presidency of India, so as to meet the peculiar contingencies of the nature of the country, the description and probable amount of traffic ; and therefore, in discussing the nature of Railway best suited to India, it will be advisable, perhaps, not to generalize too much, but to consider each on its own individual bearings and merits.

For instance, it is proposed to run this projected line of Railway from Calcutta to Rajmahal, on the old or existing roads, by which, of course, a vast expense is saved; but on the Bombay side we have very few bridged and metalled roads, and on all others the declivities are so steep as to be perfectly unsuitable for any description of rail or tram-line, whereas the plains of Bengal are almost a dead level; in fact, as stated by the writer of the pamphlet, "the profile of the natural surface of the country for 200 miles in every direction round Calcutta, is such that nothing else is requisite for the under-road formation, but to excavate a ditch on each side of a line, and throw up the earth."

Again, it is proposed to run steam locomotives on this line when necessary. Now, as a locomotive can only ascend a very low gradient, we have certainly no old or existing roads on this side of India that could be used as the under-formation of such a line, therefore, to construct a new line for such rails, on which steam locomotives are to travel when necessary, would entail as much, or very nearly as much, expense as to lay down a line at once for a regular series of *light* engines and carriages.

The description of Railway here proposed can only apply, so long as cattle power is employed (and when steam locomotives are put on, it becomes a regular

Railway, requiring all the nicety and exactness of fitting and adjustment, care and attention, in working the line, that a regular Railroad would demand) to the transit of goods, as passengers would scarcely be content to travel at the rate cattle would proceed, even upon a tram-rail, and even for goods, although it would doubtless be *infinitely cheaper* to convey merchandise along a tram-line than along even the best of our Indian roads; still the *speed* would not be so much increased, as cattle will only move at a certain, and that a very slow, pace even when they have nothing to draw; therefore, only half the advantage would be gained by adopting this proposed system of tram-rails for the main lines for general purposes.

But it is believed that these tram-rails might be most advantageously adopted for conveying the Cotton and other raw produce of the country from the native depôts to depôts on the grand line of Railways, by which the benefit of the Railway system would be disseminated through the country at a very trifling cost, as one bullock or horse will draw as much upon a tram-rail as *twelve* bullocks along a common road, taking the friction on the rail to be $\frac{1}{240}$ and on the road $\frac{1}{20}$ of the load, and on our common Indian roads the friction is even more than $\frac{1}{20}$, and these tram-rails might answer very well for conveying the Cotton of Guzerat to its shipping ports, as previously proposed.

For such purposes, then, these bar-iron tram-rails would be most efficacious, and greatly assist the development of the Railway system. But if we are to have Railways in India at all, the main lines should certainly be traversed by light steam locomotive engines, not only because increased facilities of transit, will enable our merchants to proceed personally to the agricultural districts, and thus infuse a life and spirit, which, for want of personal communication between the producer and purchaser, cannot now exist; not only that by steam, goods of all kinds, and English

manufactured articles, as well as the raw produce of the country, will be conveyed much more expeditiously; but because, one great benefit for which we look from the introduction of Railways into India, is the investment of *English* capital in Indian concerns, and the drawing the attention of British capitalists to our Indian possessions, which will assuredly never be done by commencing *now* a mode of conveyance, which, in his eyes, is looked upon not only as obsolete and out of date, but as failing to take advantage of the advancement of Science, and therefore not a system, on the furtherance of which he would invest his money or give his countenance, interest, or support. No, if we are to have Railways in India, we must begin, not where they began in England, from want of knowing better, but from the point at which they have now arrived. We must take advantage of all that their skill and science have shown to be the best. We must profit by their experience, and avoid their errors; but let us not go back half a century, or use oyster-shells for windows, when plate-glass is to be had.

Why should we suppose "that the coarse, heavy, low-priced products of this country cannot afford the expense of roads such as are constructed in England for locomotives for the conveyance of light and precious manufactures." Is not Cotton a light article, and are not Opium and Indigo precious ones; or "that in the existing condition of commerce in this country a sufficient supply of valuable goods, to form adequate loads, for locomotive engines cannot be always procurable. Let the reader refer to what is shown in "Railways for Bombay," and read what has been done in this way in countries of infinitely less size, importance, wealth, or means and appliances, than India. In Cuba, where upwards of 250 miles of Railway have already been completed, and 250 miles more are in progress; in Jamaica, and even in Demerara, where, says the "George Town Colonist," "it is becoming no novelty to see a line of trucks loaded

with forty or fifty hogsheads of sugar, rushing into the city at the rate of twenty miles an hour." Have we no sugar or no produce as bulky and as valuable as sugar? —and if, in such places as Cuba and the other West Indian Islands, Railroads traversed by steam locomótives are thus found to answer, why should we suppose that the natives of this country, who are, at all events, the class likely to invest their money in Railways, and by no means wanting in intelligence, should require to have the advantages of Railway transit *gradually* introduced to them, to begin by admiring the tram-rail, and thus be brought by degrees to appreciate the superior advantages of steam locomotion, when the inhabitants of Cuba, Jamaica, and Demerara, at *once* comprehended the superior benefit to be derived from employing steam as a motive power for the general purposes of transit, and when the Americans are daily carrying thousands of bales of Cotton, the very article we wish to convey by steam locomotion, to their great benefit and our loss.

But to show that it is not only the light and precious manufactured goods of England that are carried by rail, as assumed by the writer of the Calcutta pamphlet, but that everything of every kind is, in fact, conveyed by this mode of transit, the writer of these pages has compiled the following table from the information contained in a series of most valuable papers on "Railway Statistics," by Hyde Clarke, Esq., published in the "Civil Engineer's and Architect's Journal" during the last quarter of 1848, which it is believed will be read with interest by the intelligent native community; who can scarcely have formed an idea of the vast scale on which Railway operations are conducted in England, and of their adaptation for every description of transit.

NAMES OF ITEMS.		Average Rate of Carriage per Mile.	Total Amount conveyed by all the Railways in England in 1847.
		d.	Number.
Passengers	each	$1\frac{1}{2}$	51,352,163
Cattle, that is, Bullocks, Cows, &c.	„	$\frac{3}{4}$	500,000
Sheep	„	1-7th	2,000,000
Swine	„	1-7th	390,000
			Tons.
Coals	per ton.	$1\frac{1}{2}$	9,000,000
Ironstone	„	$1\frac{1}{2}$	628,000
Iron	„	$1\frac{1}{2}$ to $1\frac{3}{4}$	272,000
Limestone and Lime: Limestone	„	$1\frac{1}{4}$	146,000
Lime	„	$1\frac{1}{2}$	
Copper and Tin	„	$3\frac{1}{2}$	23,000
Stones for Building	„	2	500,000
Sand for Building, and Manure	„	$2\frac{1}{2}$	27,983
Ballast for Shipping	„	$2\frac{1}{2}$	36,567
Slates for Roofing	„	2	
Bricks and Tiles, returns imperfect about	„	$2\frac{1}{2}$	4,000
Total amount of Mineral Traffic, Coal, Iron, Stone, &c.			11,000,000
Timber, uncertain, but about	„	$2\frac{3}{4}$	10,000
Building traffic, Stones, Timber, &c.			715,000
Fish	„	$4\frac{1}{4}$	43,000
Grain, reckoned at	„	3	300,000
Provision traffic, Fruit, Meat, Vegetables, &c.	„	3	300,000
Ale and Beer are carried largely on some Lines	„	2	
Milk is also largely carried			
Total Provision traffic, including Fish ...			680,000
Wool is carried	„	3	
Manure traffic, Guiano, &c.	„	$1\frac{3}{4}$	40,000
Bones are carried at	„	2	
Hops	„	$2\frac{1}{2}$	7,428
Also Malt			
Bark			
Brooms			
Hay is carried, but is considered dangerous	„	3	
Total Amount of Farming Produce, Building Materials, Coals, Manure, Live Stock, Provisions, &c.			6,000,000
Also Hides, Animal Food, Cyder, Perry, Hams, &c.			
Furniture is carried at	„	10	
Parcels Traffic, containing every description of Retail Trade, Groceries, Draperies, Hardware, &c., there is no rate per mile for Parcels, but on an average for each Line they may be taken at per each parcel		4	
Mails: the receipt for 1847 was		£130,000	

NAMES OF ITEMS.		Average Rate of Carriage per Mile.	Total Amount conveyed by all the Railways in England in 1847.
		d.	Number.
Horses, carried in Horse-boxes	each	4	84,784
Carriages, on Trucks	,,	5	31,055
Dogs	,,	½	
			Tons.
Total Amount of Goods Traffic			16,699,382
Upwards of Sixteen Millions of Tons ...			
For Carrying the above articles the following Carriages are provided			
Horse-boxes, Carriage-trucks, Bullion Vans, Post Offices, ditto Tenders, Milk Trucks, Convict Vans, Cattle Waggons, Sheep Waggons, Coal Waggons, Timber Trucks, Powder Magazines, Iron Trolleys.			

The rate of $1\frac{1}{2}d.$ per mile for passengers is the average for first, second, and third class passengers. The Parliamentary trains are obliged to carry passengers at 1*d.* per mile, and on the Glasgow, Paisley, and Greenock Railway, third class passengers have been carried at *one farthing* per mile, but the usual rate is something under 1*d.* per mile.

In 1845, 20,000,000 of persons were carried by Railway, *beyond* what had ever before been conveyed by every description of conveyance previous to the introduction of Railways.

The foregoing table shows that not only light and valuable articles are carried by rail, but heavy goods, iron, iron ore, even *ballast* for shipping, stones for building, bricks, tiles, lime, slate, timber, *manure,* cattle of all kinds, fish, milk, fruits, vegetables, grain, liquor, horses, dogs, carriages, even gunpowder and vitriol, parcels containing every description of goods; in fact, every enumerable thing, light, heavy, costly, of little value, live, or dead, or inanimate, both the raw material in bulk, and the manufactured article. How can it be affirmed after this, that the coarse, heavy, low-priced products of this country cannot afford the expense of steam loco-

motive traffic, or who can now doubt but that a Railway properly established in India would pay. The foregoing table is drawn up from the most authentic sources, and is of itself worth a whole chapter of arguments on the value of Railway Steam Locomotive communication.

What a vast subject for reflection is here opened up. No more famines,—one district starving whilst in other districts there is an excess of food; the cultivator in the interior being thus enabled to dispose of his produce, will be able to afford comforts and luxuries now unknown to him. Fruit, vegetables, fish, can be exchanged for grain, ghee, oil, and, in fact, it is impossible to conceive the revolution that such a railway communication as this table exhibits would effect in India.

Some idea of the vast amount of goods thus conveyed by Railways in England may be formed from the statement that the quantity thus carried in one year would load, with a full freight, 16,999, or nearly 17,000, ships of 1000 tons burthen each, and that, supposing each ship to carry 500 persons, it would require 100,000 such ships to hold the number of people conveyed in one year in England by Railway.

Another extraordinary fact is the immense saving in meat caused by conveying the cattle, sheep, and swine, to market by rail, instead of their being driven from distances in the country to the capital towns. It is estimated that in 1847 the gross saving of animal food on the cattle thus conveyed was no less than 43,800,000lbs., which, at an average price of 4*d.* per pound, caused a saving of 730,000*l.* in this article alone of the food of the people.

The author is informed by an officer, who has for years witnessed it, that of the vast numbers of sheep fed in Candeish and the Deccan, which are sent down to the Bombay market, not *one third* reach Bombay alive, and those greatly reduced in flesh; and the same with cattle, but which would be avoided by transmitting these animals by rail.

In fish, in fruit, and in vegetables, a proportionate amount would no doubt be saved. The celebrated grapes and fruit of Aurungabad would then be common in Bombay, whilst *ice* would be largely carried to the stations in the Deccan; as well as milk, eggs, and all such perishable articles. But to secure the full benefits of this extraordinary system, *speed* is as necessary as *cheapness* of conveyance, which can only be effected by steam locomotive carriages, and not by carriages drawn by cattle, except in those districts where only heavy goods and agricultural produce is required to be conveyed.

With respect to the question of the probabilities of natives travelling by Railway, it must resolve itself into a calculation of expense, as were the natives of India to find that they could be conveyed safely by rail, and at a *less cost* than they could proceed from place to place by any other mode of travelling, there need be very little fear of their not adopting it; but the real question is, whether the poorer class of natives could, at the cheapest rate, be conveyed by Railway at a cost they could afford. It was stated that passengers could be conveyed by Mr. Samuel's steam carriages for *one-fifth* of a penny per mile; one farthing per mile is the lowest rate on any English Railway; or if we take the expenses of working the engine, for coke, &c., to be only one half more than in England, a passenger in India could be carried five miles for *one anna,* or twenty miles, a day's journey, for four annas, which, as a labourer only earns a little more than two annas a day, he could not afford; and as a traveller of the lower class expends but little more than one anna a day on his food, he would not pay more than that for transit. To a bricklayer or carpenter earning, say five annas four pies per day, if he were conveyed sixty miles, or three days' journey, for twelve annas, and these sixty miles were performed in two hours, he might still go his day's journey on foot the same day, performing eighty miles in one instead of four

days, thus saving three days' labour, or sixteen annas, from which, deducting the twelve annas fare, there would remain a profit of four annas by travelling by rail, so that native merchants or dealers, and the better class of artisans, might travel by the Railway; but it would not come within the means of the poorer classes, the most numerous class of travellers in India, so that one of Mr. Samuel's steam carriages, conveying forty or fifty passengers once or twice a day, would probably be enabled to devote the rest of its time to the conveyance of goods.

If iron can be carried from England to India at a cost of only 10*s*. per ton, the present freight, this would add only $\frac{1}{28}$th part to the cost of rails in England, at 14*l*. per ton, and the only extra expense would be the price of *coke*, which ought not to be more than half as much again as it costs in England, so that the total cost of adding an extra light line of rails and running a light 25cwt. engine on them ought not to double the cost of 1*d*. per mile at which this engine can be worked in England.

But although the advantages of employing steam locomotive power, at all events on the main lines from the several capitals of our presidencies, are thus forcibly shown, there are many points in the Calcutta pamphlet well deserving of attention. The danger of the vibrations, concussions, and shocks occasioned by the great weight and speed at which the heavy locomotives travel, unsettle embankments subject to the effects of four months' continuous rain, and thus render the repairs expensive and the roads themselves dangerous on such lines, if very heavy engines are used, the concussion of which would not only shake the rails and chairs but the whole of the permanent way. But if the principle of light engines and trains be adopted, with rails of *ample strength*, so as to be scarcely, if at all, deflected by the weight of a passing train, then the *speed* with which the engine passes will have no deleterious effect.

With regard to the rejection of masonry for bridges, viaducts, &c., and the employment of timber, laid on piles, as recommended in the Calcutta pamphlet, it will, the writer believes, be found far more economical, and at the same time equally effective, to employ iron, or timber and iron bridges, as proposed in the following chapter of this treatise, either as bridges for crossing rivers, or as viaducts for carrying the line over marshes, ravines, or deep valleys, where enormous cuttings and embankments would otherwise be required, and if the system of light engines and trains, now advocated, were introduced, these bridges, calculated for a single line, with a strain of three-fourths of a ton per lineal foot, whereas the heaviest load would only be half a ton per foot, might be constructed of very much lighter scantling than has hitherto been allowed for, at a proportionate saving of expense; and from their facility of construction, the ease with which their component parts could be carried to the site of their erection, the quickness with which they could be put up, and the power of testing before hand the strength of every part of their structure, the system of construction would, it is believed, be found particularly applicable for all situations, where bridges or viaducts are required.

Having now, it is hoped, established the advantage of employing locomotive steam power for the transit of goods and passengers on Indian Railways, and also shown the absolute necessity for light engines and carriages only on all railways constructed in India, the author would now propose a system which he believes to be peculiarly adapted to this country, whose principal feature consists in avoiding altogether high embankments by substituting a system of viaducts at an average height, say of twelve feet from the ground, and never approaching the surface nearer than six feet, where undulations occur that such viaducts cannot surmount; then cuttings must be made as in other Railways, and embankments continued from these cuttings until they

attain a height of six feet from the ground, where the viaducts are to commence.

It is proposed to construct these viaducts of wood and wrought iron combined; they may be made entirely of iron, but as teakwood is plentiful and cheap, and most durable, especially when thus raised from the ground, the employment of wood in the viaducts will, for many reasons, be advantageous. It is designed to make them of *ninety feet span* resting on brick piers, the principle of construction being somewhat similar to the framed timber viaducts in use in America, but with an arrangement securing the greatest possible strength and stiffness, with the smallest expenditure of material.

It would be out of place here to enter into a detailed description and estimate of these viaducts, which will, however, be found in the Appendix, to enable those who desire it to form a judgment as to their strength and cost, &c.: but it may be mentioned that for the passage of the small carriage engines proposed by Mr. Samuel, and previously described, both for the conveyance of passengers and goods, equal to every requirement of the branch lines, or all the Railway from the first terminus above the Ghauts, a line of viaducts might be constructed for 6,500*l.* per mile for a single line, eight feet in clear width inside the railings, and averaging ten feet above the ground, including permanent way and rails all ready for the passage of a train. This is for the *viaduct* portion of the line. The expense of that part of the line for which cuttings must be made, would depend upon the average depth of such cuttings, which would, however, be very much less than that of the cuttings of the English lines, where earthen embankments are used, and for such cuttings on a line adapted for light engines, it is believed that 3,500*l.* per mile would suffice, which, supposing the cuttings to amount to *one-fifth* that of the viaducts, would give an average of about 6,000*l.* per mile for a single line.

These viaducts are calculated of amply sufficient

strength for the passage of any English carriage train of half a ton weight per lineal foot, not for the monster engines now in use, but are fully equal to the requirements of all the branch and extension lines of the Bombay Railway.

For the main line from Bombay to the first terminus above the Ghauts, from which all the other lines will branch, a viaduct of the size of those on all European Railways is proposed, the span as before, ninety feet clear, but the clear breadth within the side railings to be ten feet for a single line, or twenty-two feet between the outer railings for a double line, and to be raised an average height of twelve feet from the ground. The strength of the viaduct is calculated to bear, without the least strain on any of its parts, a load of three quarters of a ton per foot lineal for a single line, or one and a half tons for a double line, the permanent way and rails being equal to a load on the driving-wheel of three tons, or six tons on the pair, which is more than ought to be the load of any engine used on an Indian Railway, if economy is to be considered, and the most serious accidents avoided.

The cost of such a viaduct would be 8,500*l.* per mile for a single line, and 17,000*l.* per mile for a double line, everything included, ready for the passage of a train. If the *piers* are constructed originally for a *double* line, the extra expense will be 1,000*l.* per mile, or 9,500*l.* per mile for a single line with the piers ready for the addition of another line, which could be effected without stopping the traffic for a day, one line or one truss of the viaduct being an exact counterpart of the other, and totally independent of it, thus admitting of one line being added, removed, replaced, or repaired, without in any way interfering with the other.

Making double piers at once for the smaller viaducts would entail an extra cost of 750*l.* per mile.

In the Appendix will be found a plan of these viaducts with detailed calculations of their strength, cost, &c.

The advantages proposed to be derived from adopting this viaduct system of Railway are, that although twelve feet is taken as the average height of the lower stringer of the viaduct from the ground, it is proposed that they should never approach within six feet of the surface, thus giving free passage to all animals, wild or tame, to native carts, &c.; and, in fact, in no way impeding the present free communication across the country—which a raised embankment must do. Cattle must be driven out to graze, and India being *perfectly unenclosed*, these cattle will wander and stray, and get on the rails, wearing away the embankments, and dangerously obstructing the passage of a train, rendering frequent bridges or openings in the embankments necessary. If the high embankments are not well fenced they will be constantly worn away by the tramping of cattle up them, not to mention the interruption from wild animals, such as antelopes, wild buffaloes, hogs, &c.; such animals would surely get on the embankments, if not well protected, and wear them down. All this would be avoided by the raised viaducts. Again, numerous drains must be made under earthen embankments; also side drains must be made and kept in order, the numerous small nullahs and water-courses must be bridged, all of which would be avoided by the raised viaducts, which would be equally above the effects of floods, and of the accumulation of blown sand, whilst the free passage of the train could scarcely be obstructed, as nothing but a bird could get on the platform.

For forming the necessary alterations in the direction of the line by curves, advantage would be taken of the excavations, and of the small portions of embankments connecting them with the viaducts at a height of six feet above the level of the ground, as only curves of a very large radius could be laid down on the viaducts.

These portions, including the excavations, and their connection with the viaducts should be well fenced to prevent the intrusion of cattle on the line.

By adopting this system of raised viaducts, all the disadvantages supposed to be attendant upon Indian Railways are avoided; the country is in no way interfered with, and there would be little fear of the line of Railway being obstructed, thus enabling Railways to be carried through countries whose present state of civilization forbids almost any other description of Railway being attempted.

The guards of the line for such a viaduct system need be comparatively few, and to enable them to pass freely along the viaducts, a narrow gangway may easily, if thought necessary, be added to one side by lengthening the transverse beams or girders eighteen inches; planking from girder to girder, and adding a light wire railing.

Should any objection be made to the principle of a timber and iron line of viaducts, not being of a *permanent* character, such as stone or brick would afford, it may be answered by reference to the numberless timber viaducts in America, and by an extract from a paper on American Railways in the " Engineers' Pocketbook" for 1847-48, as follows :—" The sum of 5,000*l.* per mile would be quite sufficient for the establishment of single lines of Railway in districts *that otherwise would not afford the means,* and it is better to construct Railways that shall yield a profit of from ten to fifteen per cent., even though they should last only for twenty years, than those which may last for centuries, *but will never repay the interest of their cost.*" But independent of this, a viaduct composed of *teak* timber and English wrought iron, may be kept in repair for years and years, without at any time stopping the traffic.

In the same publication the advantages of a viaduct system of Railways is thus urged :—

" Principally for the sake of obtaining gradients as perfect as possible, the English Railways have in some instances been laid out on a system which, although theoretically presenting great advantages, has, we fear,

in too many instances been carried out at *a cost for which no amount of traffic can ever repay* the proprietors.

"By the construction of timber-bridges, a great saving can be effected on the amount charged for embankments; it will often happen, especially in *rugged and mountainous districts,* that a favourable line must be abandoned on account of the expense of crossing the lateral valleys, or that works of deep cuttings are undertaken for the purpose of crossing a deep valley at such a level as will render the construction of a viaduct practicable at a moderate expense. The small cost of timber constructions, as compared with those of stone, and the comparative facility with which viaducts on the American system can be *carried across the steepest ravines,* in situations where the cost of stone bridges would totally preclude their construction, offer a ready means for avoiding in *future lines* the enormous outlay which has attended the execution of the earth works on the majority of English Railways."

The system of viaducts now proposed differs from the American only in being composed partly of wrought iron and partly of wood, and so arranged as to produce the extreme of strength and stiffness with the smallest expenditure of material; but all the above remarks, the truth of which no one can deny, apply especially to India and to the system of viaducts now proposed.

Another great advantage of this viaduct system for India is the very short time that it would take to complete a certain line, as compared with a line requiring high earthen embankments, which cannot be worked at during the four months of the rains, and will require a long time to become sufficiently firm and settled to bear the weight and vibrations of a passing train; whereas, supposing this system of viaduct Railway to be carried from Bombay to Poona, or say 100 miles, 700 masons employed for 300 days in the year

would complete the masonry of the piers in one year; or, deducting the four months of the rains, which it would be scarcely necessary to do in the Deccan, 900 masons a day would finish the piers in one year, and such a number could easily be collected between Bombay and Poona. All the wrought-iron work could be at the *same time* prepared in England, as well as the rails, whilst all the wood work could also be prepared in Bombay and Surat, where northern teak is cheap and carpenters in great numbers procurable, and whence the timber work, ready for putting up, might be sent down by boat; as also in Poona. The excavations could also be in progress for eight months of the year, and as excavations in this case would only be made where elevations demanded such work, and not to afford material wherewith to form high embankments, they would be comparatively of small amount; thus every portion of the Railway would be in progress at the same time, the iron and wood work unobstructed by the four months of rain, so that there can be no doubt but that such a viaduct system could be completed in infinitely less time than where high earthen embankments are required.

There is another most important point which must be considered, which is, that no Railway *could exist* in a country, the inhabitants of which are in general adverse to it. No police, no ordinary guards of the line, could prevent such a Railway from being constantly destroyed, giving rise to the most serious accidents. That the inhabitants of a country have the power of at once destroying a Railway whenever it so pleases them, has been practically demonstrated on the Continent of Europe. In which position do we then stand in this country in that respect? Can we expect that the natives of India, that is of the districts, will have a favourable feeling towards our Railways if they interfere in every way with their accustomed habits, rights, and privileges; if they require their cattle to be driven out to graze by cir-

cuitous paths; if they cut off all communication with their fields, except at particular spots; if their cattle require to be constantly watched, to prevent their straying on the line: if their movements are thus circumscribed and a restraint put upon their actions, will people who have hitherto been totally ignorant of what an enclosure means, who have been accustomed from the commencement of time to drive their cattle and move themselves unrestrained and unmolested, will such people approve of the Railway or submit to its restrictions and necessary precautions? We are not speaking of the Islands of Bombay or Salsette, or the environs of Calcutta or Madras, but of the interior of the country, of the districts of the wilds, through which Railways must pass, if ever they are to be of any material service, and however subdued and obedient the native population of our large cities and cantonments may be, there are those, and that not a small number, who care little or nothing for Government, and whose inclinations would rather lead them to harm than to good.

But the system of viaducts now proposed, would leave the communications of the country free as at present, as it would in no way interfere with the habits of the people, their prejudices, or their avocations, so that there would be no inducement or reason for their feeling any ill-will towards it, or of their being more inclined to damage such a Railway than they are to destroy any of our present existing bridges or roads.

This system of raised viaducts is, the author believes, the best suited to the peculiar nature of this country, and habits and prejudices of its inhabitants, he would therefore earnestly entreat those in whom the power is invested, not to scout the idea merely because it is new, but to give it a fair, patient consideration, and not to condemn it merely because it has no precedent in England, remembering that even the details of an English Railway may require as much modification to suit them to the peculiarities of our Indian empire as

do the arrangements of our houses, and that where warm, snug rooms may be the acme of all that is desirable in the one country, large, lofty, airy, and to an English idea, comfortless apartments, are in reality the beau ideal of luxury in the other.

CHAPTER III.

If we are to wait *to test* the profits of each portion of line as it is completed, much valuable time will be lost, whilst the little feelers now sanctioned neither can nor will afford any criterion by which to judge of what their eventual success would be if completed from one grand *entrepôt* to another; why should we suppose that there is anything so peculiarly inimical to Railway transit in India, that whilst they have been successfully introduced into England, America, into the wilds of which they have penetrated, all Europe, Cuba, and the other West Indian Islands, and even in Switzerland, that for the East Indies alone they are inapplicable; and why, therefore, should we hesitate at once to commence upon a comprehensive system of internal communication until the first few miles have been tested, as if locomotive transit was altogether a new and hitherto untried experiment.

We already know that iron lines of rail *can* be laid, and that steam-locomotives *can* travel on them; the only point left to be ascertained, as regards their introduction into this country, is whether there is a sufficiency of traffic of particular kinds to make the speculation a profitable one; every endeavour ought therefore to be made to ensure, by every available means, the success of the first constructed lines; but this will not be done by running a small portion of Railroad into the jungle and leaving it there; a fraction of a line will never show what the effects of a line completed between any two places of importance would be. The first locomotive Railway in England was carried from Liverpool to Manchester, *con-*

necting those two large and important towns, by which travellers found themselves carried from one place of business to another in an incredibly short space of time; their merchandise was also conveyed at once from the shipping-port to the manufactories with equal rapidity and facility, by which the great advantages of steam-locomotive transit were *at once* practically shown, and the new system at once took; but had the line of rail been laid down from London even, and carried thirty miles in any direction, and then stopped either at a small unimportant town, or on a heath or common, being, in fact, of no positive immediate benefit, it can scarcely be doubted that it would have proved a failure; but in England they knew better what they were about,—they made the first line of Railway useful at once; they made it *complete in itself*, by which its merits were at once seen and acknowledged.

But how different is the system about to be adopted in Bombay: the first start to ascertain, not the feasibility of constructing Railroads, for of that there can be no doubt, but their suitableness to this country is to be made at a point offering the smallest opportunities of testing the *general* usefulness of a Railroad. True, Callian may possess 40,000 inhabitants, all natives of India, very few of whom can ever *afford* to travel by rail. The line by the Malsej Ghaut may also be made available for the transit of Cotton and other native produce to Bombay; but we hope to see Railways do something more than this,—to be of use and application not only to the merchant but to the community generally; whereas, nothing but merchandise will pass on the Callian line, and it is very doubtful whether its merits, when constructed so far, will ever be duly appreciated, for by the time the bringaree, or up-country trader, with his string of bullocks or carts, has reached Callian, he feels his troubles at an end, his dangers and difficulties over, and he will scarcely say, "thank you" to have his merchandise carried the remaining small and easy portion

of his journey, by which two or three days out of as many months may be saved, and that at a considerable cost, as he must retain his cattle, &c., at Callian at a certain expense to convey his return investment into the interior, whence he came; and as, moreover, he has already, from this point a cheaper mode of transport by water than the rail can ever supply, the line to Callian will, therefore, be of little or no *possible* benefit, in the eyes of the up-country trader. It will be of very little use as a passenger-train to natives, very few of whom can afford to travel by it. It will be of no use to Government, except in an indirect manner, as, with the exception of the small station of Malligaum, it must be carried no less than 360 miles before it reaches a military station; and it will be of no use to the community generally; in fact, no line could have been selected possessing so little *general* usefulness as this Malsej Ghaut line.

The hire of a Cotton boat from Bombay to Tanna is 5 rs., or 10*s.*: these boats carry forty bales of Cotton, or at least six tons, at the rate of 1*s.* 8*d.* per ton; or say it only carries four tons, the rate will be 2*s.* 6*d.* per ton. Now, Tanna is twenty-two miles from Bombay by land, which, at $2\frac{3}{4}d.$ per ton per mile, would entail a cost of 5*s.* $0\frac{1}{2}d.$ per ton for Cotton carried by rail from Tanna to Bombay, or either *two* or *three times* what it is now carried for by sea; how, then, is it to be expected that the line to Tanna and Callian can pay, if it produces any returns at all; and if so, is it good policy to construct, as an experimental line, on the result of which is to be decided the question, whether or not Railways are to be introduced into Western India, one that cannot be expected to pay its working expenses, and has to compete with a water-carriage, by which goods can be conveyed at one-half, or one-third the cost? Surely this is not the way to induce either the native or the English capitalist to risk his money on an undertaking which, when its first novelty has worn off, cannot compete with the present existing means of transport.

But were the first Railroad *completed* between Poona and Bombay, the case would be very different, and an immediate benefit would be derived from passengers and goods traffic. Poona, the seat of Government and the head-quarters of the army for *one-third* of the year, a military station usually occupied by at least 3000 European troops, among whom is a regiment of Dragoons and a brigade of Horse Artillery, constantly requiring large supplies of every kind; besides native troops, and a native population of 7000 or 8000 persons connected with the camp Bazar, with a large arsenal and depôt of military stores; the resort of a numerous European community for several months of the year. The capital of the Deccan, a city containing 70,000 inhabitants, on the direct road to Ahmednuggur, the head-quarters of our artillery and principal depôt for guns and military stores, in the direct line to the valuable districts of Sholapoor and the Southern Mahratta country, and onwards to the Madras Presidency; also to the Nizam's dominions and the Calcutta Dawk line. Poona, with all these advantages, with troops, military stores, European supplies of all kinds, and in vast quantities, constantly passing and repassing, might well support a Railway of her own, were it not that the line of intervening Ghauts presents an obstacle which it seems absurd to overcome at more than *one* point; but with the advantages of its position as the first terminus between Bombay and the whole of India, added to its own requirements, it does seem a pity that the Ghauts which must be surmounted, should not be ascended in the line to Poona.

By the completing a line at once to Poona, leaving the Ghauts for the present to a system of porterage, until the expense of carrying a rail of some kind up it can be better afforded, the advantages of steam-locomotion would be at once exhibited, and the Government, without whose liberal assistance the Railway must have died in embryo, would be among the first to reap the advantages of its liberality. The saving that would be effected

on the transport of military stores, ammunition, commissariat supplies of all kinds, to meet the demand of 4000 European troops, including those at Ahmednuggur, would be immense. The permanent conveyance establishment of the commissariat at Poona amounts to 6000*l.* a year. The economy not only in money but in life, in moving a European regiment from Bombay to Poona, on its first arrival in the country, and whenever required for immediate service, thus making Poona the garrison for the European troops of this Presidency, would be equally remarkable. The facilities of communication between the official organs of Government, especially during the four months of the monsoon, these, one and all, would make Poona almost a suburb of Bombay, at an elevation of 1800 feet above it, with all the advantages of a healthy climate, to be reached by a journey of four hours' duration, even allowing one hour for the passage of the Ghaut.

Thus the first constructed line would be complete within itself, whilst its advantages would not be confined solely to one object,—that of the conveyance of merchandise,—but would be felt and appreciated by all classes of the community, and this 100 miles of rail would do more to give a favourable impression of the value of this, to India, new system than 300 miles of Railway would, if extended in the proposed direction towards Indore.

Poona would also be equally efficient as a terminus for merchandise and the produce of the country, with Alleh, the proposed point of bifurcation of the lines north and south; for, suppose the line of rail to be carried from Bombay to Poona, thence by Seroor to Ahmednuggur, thence to Aurungabad, and thence by the pass at Adjunta to Boorhanpoor: by this line the distance to Boorhanpoor on the north, and Seroor on the south, whence the southern line would be continued, would be about 356 miles; whereas, by the proposed Malsej Ghaut line, the distance to Boorhanpoor on the

north and to Seroor on the south is about $330 + 36 = 366$ miles. By the Aurungabad route 356 miles of Railway would connect Bombay with the large city and military station and entrepôt of Poona, the city artillery depôt of Ahmednuggur, the large city and station of the Nizam's army, Aurungabad; thus opening up the whole of the Nizam's dominions to the rail, whilst by 366 miles of rail by the Malsej Ghaut, the single small station of a wing of a native infantry regiment, Malligaum, would be passed, and that is all. The small camp of Seroor is common to both lines. On the one line, not only merchandise, Cotton, grain, salt, &c., but light valuable goods and parcels, passengers, troops, military stores, English stores and supplies of all kinds would pass. On the other, nothing but the Cotton, grain, salt, and such heavy and bulky articles could be required. On the Poona line the electric telegraph, which is made a *sine quâ non* of the Railway system, would virtually seat the Governor and Commander-in-Chief of the Presidency at the Council Board in Bombay whilst residing at Dapoore and Poona, whilst on the Malsej line, for the first 350 miles the Bheels of the jungles or wild beasts of the forests would be nearly the sole representatives of animal life with whom such communication could be made.

And in addition to all, the favourite Oomrawutty and its Cotton would be brought some thirty miles nearer to the line by Adjunta than it is to the proposed Malligaum and Boorhanpoor line.

In the letter from the Chairman of the Railway Committee to Government, detailing the advantages of the proposed Railway, the facilities thereby afforded for the conveyance of troops, and the transport of military and commissariat stores is strongly insisted upon, and rightly so as regards railways generally; but surely the map could not have been consulted when pointing out the above as among the advantages of the Malsej Ghaut line, which in a course of 350 miles would communicate

with one wing of native infantry. It may be said that although the Malsej Ghaut has been selected for the line by which the table-land of the Deccan is to be gained, that it is fully intended to bring Poona within the influence of its benefits, and, indeed, Government have already been requested by the Railway managers to make a branch road from the Poona and Panwell mail road to join the Railway line near Callian; but if this is the manner in which it is proposed to effect the purpose in view, it is feared it will be found a great mistake, for once below the Bhore Ghaut, and near the junction of the proposed branch-line, no traffic would go round by Callian merely for the pleasure of having a ride on the rail, with Panwell directly and close in front, from whence goods can be conveyed to Bombay by water for less than one-third the cost of transit from Callian to Bombay by rail; it is, therefore, difficult to conceive what object this branch-line is proposed to effect.

Neither is there any other method by which Poona could be connected with the Malsej line; where it is proposed to join it below the Ghaut, certainly would not answer, and if an attempt is made to connect it above the Ghaut the same result will be obtained, for supposing a branch-line to be carried from Poonah to Alleh (for which the country presents great difficulties) such a line would be about forty-five miles in length; Alleh is 110 miles by rail to Bombay, or $110 + 45 = 155$ miles, which at $2\frac{3}{4}d.$ per ton per mile, gives $426d.$, or $35s.\ 6d.$ as the cost of conveying a ton of goods from Poona to Bombay by rail by such a line. By Mr. Chapman's tables the cost per ton from Poona to Panwell by carts on the present road is $2s.\ 8d.$, or $2s.\ 9d.$ per ton per mile, for seventy-two miles, and from Panwell to Bombay by water is as before shown from $20d.$ to $30d.$ per ton, or $20 + 825 = 233d.$, or $20s.$ per ton, as the cost of conveying a ton of goods from Poona to Bombay by the present transit, or say $24s.$ per ton, allowing for expenses in

loading and unloading the boats, &c., which is only two-thirds the cost of carrying it by rail, so that a branch-line from Poona to Alleh is out of the question.

To connect Poona with Seroor, and so with the Malsej Ghaut line, would be still worse. Poona, therefore, under the present arrangements, is entirely and hopelessly cut off from all participation in the benefits of the introduction of Railways into India.

The reasons for the selection of the Malsej Ghaut line have not been made public; but as great stress is laid upon the peculiar advantages this Ghaut offers for the construction of a straight inclined plane up which trains could be drawn by stationary engines, or by some other arrangement, it is probable that it is to this supposed facility of reaching the elevated table-land that this otherwise most unsuitable line has been selected, and it is, therefore, worth while to examine what these great advantages are that the Malsej Ghaut possesses, and how far they are of a character to justify the selection that has been made. In the first place, as to height of plane to be ascended by means of stationary engines, &c. According to the engineer who surveyed this line, Mr. G. T. Clarke, the length of the plane is 10,267 yards, and the average inclination one in eighteen, this would give upwards of 1800 feet as the height to be ascended. Mr. Chapman says that by the inclined plane an ascent of 1700 feet is attained, and a progress in the direction of the road of six miles, and this last may at least be taken as the height of ascent of the Ghaut. Now Khundalla on the summit of the Bhore Ghaut, although 1750 feet above the sea, is only 1500 feet above the village of Capoolee at its base, so that here the direct ascent would be 200 feet less than at the Malsej Ghaut. But the total rise of the Thul Ghaut is only $933\frac{1}{3}$ feet, or little more than one-half of what has to be surmounted at the Malsej Ghaut; in fact, the very advantage claimed for the Malsej Ghaut as "standing at the head of a bay," or tract of nearly level ground, from which it rises

abruptly, must necessitate a greater ascent to reach the table-land, than where the ground, as in other places, rises gradually but surely from the sea to the foot of the Ghaut, thus greatly diminishing the actual height to be surmounted by an inclined plane.

The Malsej Ghaut, therefore, possesses no advantages on the score of height to be surmounted; nor with regard to the reported facilities of constructing an inclined Railway plane up this Ghaut.

To affect this it is necessary to excavate no less than *eight* tunnels, including one on the very summit of the Ghaut, and continuous with the inclined plane, amounting to no less than 3981 yards in length, which at 64*l.* per running yard, the *average* cost of the tunnels actually constructed on the English Railways (*see* Appendix C) would entail an expenditure of 254,784*l.*, or half the total amount on which the guarantee of five per cent. is allowed, whilst to reach the summit of this Ghaut from Tanna requires the piercing of no less than fifteen tunnels, amounting in the aggregate to 9,981 yards in length, and costing at 64*l.* per yard, no less than 638,784*l.* for tunnelling alone between Bombay and Koorla, or 425,856*l.* for a single line, for which a total sum of 981,027*l.* for the whole expenses of the line, including rails, &c., is estimated, so that on a line whose total length is eighty-six miles, 5·67 miles, will cost one half of the estimated amount, leaving the remaining eighty miles to be constructed for one half of the sum allowed for the whole line.

In piercing tunnels for the passage of Railways, the only guide we can have of the probable cost, must be the results of the actual expenditure on similar works, and the average of such expenditure in England has been, as before stated, 64*l.* a running yard, and there can be no reason to suppose that this description of work will be carried on at a less expenditure than in England. Most, if not all, of these tunnels will have to be carried through basaltic rock, every inch of which

must be blasted. Some of these tunnels of from 1400 yards to 1600 yards in length, are intended to pierce hills from 400 to 600 feet in height. Conceive the expense of sinking the necessary numerous air-shafts to such a depth through such rock, and if these air-shafts are not numerous, the workmen will sink from heat and suffocation before they have penetrated 150 yards. The estimated cost of these tunnels has been calculated from the cost at a liberal allowance of well-sinking to a depth of eighty feet through similar rock at Poona: but what analogy is there between a tunnel 1600 yards long through a hill some hundreds of feet in height, and a well eighty feet in depth, or what analogy is there between the actual cost of 64*l.* a yard for Railway tunnels in England, and the cost of well-sinking in England. But as it is solely by means of these tunnels that the straight ascent up the Malsej Ghaut is obtained, it is deserving of most serious consideration whether the expense of this extensive system of tunnelling has not been most unaccountably under estimated, indeed to an extent to swamp the whole expected profits of the Railway, if the actual expenditure on tunnelling in England is taken (as it should be in the absence of any other datum) as the probable cost of tunnelling in India.

There are besides the above, two more tunnels between Alleh and the Pera River of an aggregate length of 2466 yards; a line, therefore, that in a distance of 140 miles requires no less than seventeen tunnels, amounting altogether to *seven* miles in length, or one-twentieth of the whole line, cannot surely be called an easy line, or one presenting no difficulties, as by engineering difficulties, now-a-days, must be understood pecuniary difficulties, since English skill and perseverance have struck any other interpretation of the word out of the dictionary; that such a line in England would be inadmissible, there can be but little doubt, nor ought there to be any that it is inadmissible in India.

Nor have we any reason to suppose that there is any pass along the whole range of the Ghaut mountains, including the Bhore Ghaut, that English science would not overcome, or that would probably present more expensive obstacles than the Malsej Ghaut Line, and, therefore, peculiar facilities of construction cannot be advanced as the reason for selecting this line.

If then neither the amount of ascent to be overcome nor the facility of overcoming this ascent, is in favour of the Malsej Line, can its direction claim for it the pre-eminence.

Situated as Bombay is, on the verge of the Western Coast of India, any comprehensive system of internal communication, must embrace three main directions, north-east, east and south-east, which it is clearly impossible for any one direct line to compass. In the proposed line of Railway, therefore, the line after passing nearly east to the Malsej Ghaut, bifurcates after reaching the summit, one line taking a north-easterly direction towards Boorhanpoor, and the north-west provinces of Bengal, and the other a southerly course to Seroor, and so on to Sholapoor and the south-eastern districts. Now it has been shown above that to attain this result a greater length of line is required than there would be by taking the line by Poona. The *direction*, therefore, of the line by the Malsej Ghaut offers no advantages.

Independent, however, of the Malsej Ghaut Line not possessing any advantages within itself, there are other and strong reasons against its adoption as the main line for the Railway.

About thirty miles north of the Malsej Ghaut, in the same range of hills, lies the Thul Ghaut, down which a most excellent cart-road has within the past year been completed by Government at a very great expenditure of money, which has, however, obtained perhaps the best Ghaut road in India, if not in any other country; by this Ghaut the table-land of Candeish is reached by an ascent of five miles in length, and $933\frac{1}{3}$ feet of actual

rise; the average inclination of the road is one in twenty-nine, and the greatest slope one in twenty. Such a road metalled with stone and with such gradients, offers but little if any obstacles to transit; and so well situated is this Ghaut for the carriage of the produce of Candeish to Bombay, and *vice versâ*, that in the first eight months and a half after its complete opening, no less than 50,000 tons of goods passed over it, being at the rate of nearly 60,000 tons in the year, allowing one-sixth the traffic for the remaining three months and a half of the rains; and so direct is this line from Bombay to the districts north-east of it, and to what are called the North-west Provinces of Bengal, that there is no doubt but that if it was not equally necessary to reach the eastern and southern districts as well, that the Thul Ghaut Line would be the best. But as this Ghaut leads to no large or important stations until at a very great distance from Bombay, it would not be a good line for the general and comprehensive purposes of a steam Railway, *although quite equal to the Malsej Ghaut even in this respect;* but for the conveyance of merchandise of the produce of the country, and of heavy and bulky goods from Bombay to the whole of Candeish, there can be no doubt of the superiority of the Thul Ghaut Line over that by the Malsej Ghaut, no better proof of which need be desired than that by it the produce of Candeish would reach Bombay by thirty miles less distance, and could be carried by a line of tram or plate rails, with cattle draught, from Malligaum to Bombay, by the Thul Ghaut, *at less than one-third* the cost of conveying it by rail by the Malsej Ghaut (*see* Appendix B), and would reach Bombay, a distance of about 183 miles, in little more than three days and a half, which, for Cotton, for grain, for salt, and such articles, would meet every present requirement.

It is not to be expected that the natives of Candeish would willingly pay three times as much to send their produce to Bombay by rail, as it would cost them to

transmit it by a tram-line by the Thul Ghaut in three days and a half; nor is it to be supposed that any Government would be justified, or would be willing to sanction, a monopoly of transit that should thus oblige the inhabitants to pay three times as much for the transit of their produce and requirements, as they could obtain them for by other channels, or insist upon their sending their produce 213 miles at $2\frac{3}{4}d.$ per ton per mile, when they can have it conveyed to the same place (Bombay) by a distance of 183 miles at $1d.$ per ton per mile; and yet this is what the Malsej Line proposes to do regarding Candeish. Let any one who doubts this refer to the map, and wade through the calculations in the Appendix, and he will then be satisfied that such is the case; and yet the *very existence* of the Railway, as now arranged, depends upon securing the *whole* of the traffic that now passes down the Thul Ghaut.

For Candeish then, the only present, or, in all probability, future requirements of transit, is the conveyance of heavy bulky articles of produce and manufacture, all of which can be brought to their doors infinitely cheaper, and quite quick enough, by the present line of the Thul Ghaut, than they could by a Railway up any other line, and therefore, for all the requirements of such a district, in which there are no large important cities or military stations, a tram-line, worked by cattle-draught, is, for the present, all that can be desired; whilst for communication with the eastward, the southward, and eventually with the North-west Provinces of Bengal, with the Oomrawutty Cotton districts and Berar, with the Nizam's dominions; and for the general comprehensive purposes of a steam-locomotive Railway, the line by Poona and Aurungabad offers every desired advantage, and connects more large and important towns, and opens up the trade of a larger portion of country than perhaps any other line of similar length in India.

From Bombay to Colsette Bunder, near Bhewndy, a distance of about twenty-three miles, there is water-car-

riage to Bombay, the cheapest of all possible transit for heavy and bulky goods; from Colsette to the foot of the Thul Ghaut is forty-eight miles by the present old and wretched road, though it is probable that the new line about to be surveyed may somewhat shorten this distance; the length of the new road up the Ghaut is five miles and a quarter, and from the summit of the Ghaut to the town of Nassick is thirty-four miles, and from Nassick to Malligaum, the capital, and about the centre of Candeish, is sixty miles; to reach the point of water-carriage from Malligaum would therefore require only 147 miles of plate-rail or tram-road, instead of 182 miles to reach Callian, also connected with Bombay by water, by the Malsej Ghaut Line.

But if the tram-line were completed to Nassick, or a distance of eighty-seven miles, every desirable object would be obtained, and by this line goods, such as grain, salt, Cotton, which form the three principal articles requiring conveyance, could be carried at the rate only of 1*d.* per ton per mile, or one-third the cost of conveying goods the extra distance by rail, and at this rate yield a dividend of from 12*l.* to 14*l.* per cent. on the cost of construction and working.

Another advantage of adopting this Thul Ghaut Line would be, that as the new Ghaut road forms part of the line, the transit company would either purchase the whole right of road from the Government, or pay a toll per ton per mile for everything carried up or down it; thus the great outlay on this Ghaut would be well repaid, instead of being totally thrown away, if the Malsej Line is to monopolize the whole of the traffic from the table-land to Bombay. The tolls now received by Government from the Bhore Ghaut, or rather the sum at which the tolls are farmed, amounts to somewhat more than one rupee per ton of goods that pass the Ghaut, as, in 1848-49, about 40,000 tons of goods passed by this Ghaut, and the tolls were farmed for 50,000 rupees; if, therefore, the traffic by the Thul Ghaut has this year

amounted to 60,000 tons, there is at once a sum of 60,000 rupees, or 6000*l.* of tolls which will be lost to Government if this traffic is drawn away from the Thul Ghaut.

There should be no mistake on this point: the absolute annihilation of all the traffic, both by the Thul Ghaut, the Bhore Ghaut, and every intervening pass, is contemplated by the Railway company, and the calculated dividend depends solely and wholly upon the rail monopolising the whole transit of every description of produce and goods from the whole table-land of the Deccan and Candeish to the Concan. The dividend of eleven per cent. is calculated on the Railway carrying 180,000 tons a year; of this 81,530 tons are the ascertained exports and imports from Bombay to *every port in the Concan,* including grain, after deducting one-fourth for traffic of the small ports at the northern and southern extremities of the line, which could neither pass by the Thul Ghaut or by the Bhore Ghaut, as it includes everything passing from Bassein on the north to Sanksee below Alibaugh on the south.

The whole of the traffic by the Thul and the Bhore Ghauts is, therefore, supposed to come by the Malsej rail line.

The next item is 80,000 tons of salt, to be conveyed into the interior from the Concan. The actual supply of salt in the Concan, after deducting the quantity retained for local consumption in Bombay, &c., and that carried away by sea to other ports is only 64,629 tons, out of which 51,691 tons are from places between Bassein and Sanksee inclusive, or the line from which the *whole* traffic is supposed to go by the Malsej Ghaut. All the salt, therefore, now reaching the table-land by the Thul and Bhore Ghauts must go by the Malsej rail, if a dividend is to be paid.

The two principal items of produce that now go down the Thul and Bhore Ghauts to Bombay are grain and Cotton; but both of these being shipped to Bombay either from Panwell or Colcette Bunder, or Callian, *are*

included among the 81,530 tons of exports and imports *from the Concan,* in which these two places are included.

So that the whole of the grain and Cotton now passing by these Ghauts must go by the Malsej rail, if a dividend is to be paid.

Having thus accounted for 161,530 tons out of the 180,000 tons estimated for as to be carried by the Railway, and on which its existence depends, and shown that nearly the whole of this traffic now passes either by the Thul or the Bhore Ghauts, it is clear that the traffic by both of these Ghauts must be *entirely annihilated* if the proposed Railway is to pay a dividend. The money, therefore, spent on the Thul Ghaut must be entirely thrown away, and the profits to be derived from the tolls given up if the Malsej line is adopted.

In 1848-49 upwards of 40,000 tons of goods passed by the Bhore Ghaut, as calculated from data of the actual traffic obtained through the kindness of the collector of Tanna, and 50,000 tons have actually passed the Thul Ghaut during eight months and a half of the past year, according to data most accurately obtained by Lieut. Chapman, of the Engineers, the officer in charge of that Ghaut, which will give at least 60,000 tons for the year, hence we have 100,000 tons as the transit of these two Ghauts. What the actual traffic down the small intervening Ghauts between the Thul and the Bhore Ghauts may have been this year, the author has not been yet able to ascertain; but considering the excellence of the new Thul Ghaut road, and that the tolls have not yet been imposed, it is more than probable that nearly the whole of the traffic that used to go by the small Ghauts north of the Bhore Ghaut has this year gone by the Thul Ghaut.

That this 100,000 tons of actual traffic should fall below Mr. Chapman's estimated traffic ought not to create surprise, as that gentleman's assumption that *three-fourths* of the whole exports and imports from every port in the Concan would be conveyed to the table-land,

is probably far above the mark, whilst a transit of 80,000 tons of salt is calculated upon; whereas the present total produce of the Concan, after the deductions made by Mr. Chapman himself, is only 64,629 tons, so that the present traffic to and from the table-land must necessarily be less than that assumed in the estimated traffic on the Railway.

But of this the above exposition can leave no doubt, that unless the proposed Railway monopolised the whole traffic now passing by the Thul and Bhore Ghauts, it could not pay its dividend; and that if this dividend is paid, then the money expended on the Thul Ghaut will have been entirely thrown away, and the great advantages of this beautiful Ghaut-road annihilated; whereas, by adopting the plan now proposed, every rupee expended on this Ghaut will turn to great profit, so that Government will be well remunerated for what they have expended, and the natives of the country will derive all that benefit that the situation of the Thul Ghaut entitles them to.

As for any proposed junction or branch from anywhere between the foot of the Thul Ghaut and the Railway near Callian, what possible good could such a project effect, as it has been shown that the Malsej line must carry all the traffic *down* the Ghaut or pay no dividend? and it can never be allowed that the expense of connecting the road between Colsette Bunder and the Thul Ghaut with the Callian line, is to be undertaken merely to bolster up the supposed transit on the profits of the Railway *before it has ascended the Ghaut*, as we are not speaking, neither ought we for a moment to consider the Railway as merely reaching to Callian, or to the foot of the Malsej Ghaut, but as completed in its comprehensive form, and as a system of Railway communication for Western India, and not for an isolated fraction of that system.

Another advantage of this Thul Ghaut line is, that the most difficult and most tedious portion of the ascent

to the table-land is already completed; the present road from Bhewndy to the foot of the Ghaut is so bad that an entirely new line of road is now in course of being surveyed, so that under any circumstances, either a common road, or a tram-line must be newly-constructed, whilst the present road from the Ghaut to Nassick is not a bridged or a stone-metalled road; there would, therefore, be nothing to *undo* in adopting this line. And as regards the ascent of the Ghaut itself, little or nothing would require to be done; the average slope is one in twenty-nine—the greatest, one in twenty; and it is considered from personal observation, that loaded carts could ascend and descend this Ghaut in the same time, and with the same average exertion that they pass over any ten miles of ordinary road on the plains, so that no extra cost of transit would be entailed by the Ghaut. A pair of horses in a carriage may be trotted down the Ghaut without even using the drag-chain, and may be trotted up the Ghaut by allowing a short rest for recovering their wind: the only thing that would be required on this Ghaut might be the laying of a *stone* tram-line up it, so as to secure a hard even surface for the wheels of the trains during the monsoon. The draught up an incline increases greatly, as compared with the draught on a level, as the friction of the road decreases; that is, if the friction on a common road is one-thirtieth of the load, and the slope one in twenty, two horses and a half will be required to draw the same load up the slope that would be necessary on the level road; whereas, if the friction is reduced to one-seventieth of the load, as on a pavement, it would require four horses and a half to draw a load up an incline of one in twenty, that one horse could draw on such a pavement on the level; but a horse can draw three and a half times the load on the pavement that he could on the road, and, therefore, if one horse is sufficient for a certain load on a common level road, whose friction is one-thirtieth of the load, then $\frac{30}{70} = \frac{3}{7}$th of a horse would be capable of draw-

ing the same load on a rail, or $\frac{2}{7} \times 4\frac{1}{2} = 1\frac{2}{7}$th norses would draw the load on the pavement up an incline of one in twenty; whereas two horses and a half would be required to draw the same load up the same incline on a common road; so that the advantage of the paved line over the common road would, in the dry season, be as $2\frac{1}{2}$ to $1\frac{2}{7}$th, and in the rains infinitely more. But should there be no difficulty in stopping the velocity of the trains down an iron rail, on an incline of one in twenty, by means of breaks, or other contrivances, it would be still better to lay a line of plate-rail up the Ghaut, similar to that on the plain, on which, by the above reasoning, one horse, or exactly $1\frac{1}{11}$th horses would draw a load up such a rail that would require two-and-a-half to draw it up on a common road, the proportion in this case being as $2\frac{1}{2}$ to $1\frac{1}{11}$th, or nearly as $2\frac{1}{2}$ to 1. (*See* "Whewell's Mechanics of Engineering.") This, then, would be the only addition required to the present Thul Ghaut line to fit it for the passage of a tram-line.

It is, therefore, believed that the Thul Ghaut offers in every respect the best line of communication for the transit of heavy goods, &c., to and from Candeish and Bombay, and also that nothing but such heavy and bulky goods will ever pass through these districts, even were a steam locomotive Railway, such as that proposed on the Malsej Ghaut line, carried through them.

One more advantage of making the Thul Ghaut and Nassick line one for cattle draught may be mentioned, that it will tend to keep up a good breed of cattle, both for the purpose of the line, and for bringing the produce of the country to the terminus; thus giving present employment to the Bunjarrees and their cattle, and securing a breed of cattle being constantly kept up, a point of considerable importance; for without these Bunjarrees and their cattle, not an army could take the field, or move in any direction, but in the precise line of the Railways; and, therefore, as Candeish is a purely agricultural country, a better field for giving present

employment to, and securing the continuance of the breed of these Bunjarree cattle could not be selected, whilst by such a tram-line every requirement of such a producing country would be amply met.

This is a point of political importance to the Government, and of justice to the deserving tribe of Bunjarrees, whose myriads of pack bullocks cannot, as has been well observed, be boiled down into tallow like Australian sheep, or all salted into provisions like the German post-horses, and whose claims should be attended to when their occupation is taken away.

It may be said that as the Malsej Ghaut line could not exist without the monopoly of the whole of the traffic from the table-land, that neither can the line by Poona do so; and that proposing a line by the Thul Ghaut, to bring down all the produce of that district, is virtually cutting the throat of the Railway. To this, two answers may be given. First, that the Malsej Ghaut line could not have monopolized the traffic that now passes by the Thul Ghaut, without *the greatest injustice* to the producers and traders of that country, by insisting upon their paying three times as much as they need do for the transport of their produce: and, secondly, by adopting the Poona line, an immediate and direct Railway communication is made with the whole of the Nizam's dominions and countries to the eastward—which will more than compensate for the traffic of the Thul Ghaut,—whilst the Poona line, having the benefit of being the direct line of communication between several large cities and military cantonments, would enjoy advantages that the Malsej Ghaut line never could. And, moreover, the Railway Company should undoubtedly undertake the Thul Ghaut tram-line as a component portion of their operations; thus securing to themselves the whole of the traffic from the interior of the country to Bombay, with the best possible expectations of success from suiting their lines to the precise purpose for which they are required, whilst at the same time the interests of

Government, and of all the inhabitants of the country, would be best considered.

Having thus shown that the Thul Ghaut line is the best, both as to direction and facilities of construction, for the conveyance of goods, produce, &c., to Candeish and the bordering districts, it now remains to demonstrate that the Poona line is the best first terminus for the Grand Trunk Railway, and for the development of the Railway System generally in Western India, as also as the Grand Southern, and Eastern, and, eventually, North-eastern communication between Bombay and the Continent of India.

In the first place, the argument already used may be repeated—that by completing only 100 miles of Railway from Bombay to Poona, the first Railway is made *complete in itself*, and will instantly begin to yield a profit. One hundred miles to Poona would complete a journey, would land a passenger, troops, government servants, goods, parcels, letters, the mail, &c., &c., at their intended destination; whereas 100 miles on the Malsej line would leave a passenger standing amid the ravines and hills of the wild country near Alleh, with everything strewed around him,—in fact, not so well situated as before he commenced his journey from Bombay, with the Panwell Mail Road, or Thul Ghaut at his command. Of the advantages of the nimble sixpence, no one ever entertained a doubt; of the desirableness of turning one's money as quick and as often as possible, to secure an eventual maximum of profit, no one is more alive to than the Bombay Merchant; and, therefore, that it must answer better to construct a line of Railway *(cæteris paribus)* that will begin to return a profit on the completion of 100 miles, than one that must be carried three times that distance before it will make any return, there can exist but little doubt. And this great advantage the Poona line offers: by completing the line *at once* to Poona, the real capabilities of the Railway system will be at once developed, and its

superiority shown; the native merchant who could see his goods lodged in his warehouse four or five hours after leaving Poona, could receive intelligence by Electric Telegraph in a few seconds,—could put himself into a carriage and find himself at his home, in Poona, in little more than four hours; who could receive his fish, fruit, vegetables, as fresh as they left the sea or his garden, would soon, very soon, comprehend the value of a Railway communication. But, complete a line to the foot of the Malsej Ghaut, or to its summit, and what is gained? Nothing—absolutely nothing: and that native would be quick-sighted indeed who could from such a communicant appreciate the advantages, or anticipate the ultimate success of the system of Steam Locomotion.

Let the Malsej Ghaut line, then, with its seven miles of tunnels through hard rock, and its prospects of beginning to return a revenue (not a profit) after some eight or ten years' labour, be at once abandoned, and a line selected that does not present these difficulties, and if carried out with vigour and determination, might, in less than a third of that time, commence yielding a real return to the proprietors, and at the same time prove of great and immediate benefit to that Government, without whose aid and liberality the Railway Company could not exist at all.

Supposing that the line to Poona be determined upon, the next consideration is, whether the line should run *direct* from Bombay to Poona by the nearest straight line, or whether it should be carried round by Tanna, thus considerably increasing the direct distance. No doubt this point was well considered before selecting the Malsej line; but this Essay would be incomplete were not this important point, affecting the very commencement and situation of the terminus of the Railway noticed, and the real state of the case on each side put in as clear a light as possible.

The most direct line from Bombay to Poona would be gained by crossing the harbour to Inora Bunder,

on the Island of Carranja, and thence by the Bhore Ghaut to Poona, a distance of eighty-seven miles and a half, to the centre of the cantonment, or eighty-four miles and a half to the Sungum, where the Poona terminus must be situated. This line has been surveyed, and reported upon, and strongly recommended, by Captain W. D. Graham, of the Engineers, the Superintendent of Roads and Tanks, from which source, solely, the present information is obtained. The passage from Bombay to Inora Bunder is only six miles, and it is said that it can be crossed at all times and seasons; whilst, at Inora, a good Bunder or landing-place, can be constructed, where there is a plentiful supply of water, and ample space for a Railway terminus; from this point to the foot of the Ghaut, the road runs chiefly up the Apta valley, and is said to present no difficulties whatever to the construction of a Railway—certainly none of the tunnels of the Malsej line—the chief obstacle being the crossing of the creek, separating the Island of Carranja from the main land, and which is not more formidable than the passage of a similar creek at Sion, whilst the crossing of the Tanna river, or creek, would be saved. As either line must come by the Bhore Ghaut, and thence follow the same course to Poona, there can be no occasion, for the sake of the present comparison, to follow this road further.

By this road, then, the distance by rail to the Sungum at Poona, would only be seventy-eight miles and a half, the whole line throughout, with the exception of the Bhore Ghaut, presenting no obstacle or pecuniary difficulty whatever; but then there is a passage across the mouth of a harbour six miles in breadth, and on the result of a consideration of the difficulties and inconveniences attending such a crossing, must depend the question, whether the Inora Bunder line should be chosen or not. For the eight fair-weather months of the year, there could be no difficulty or inconvenience in effecting such a crossing. The floating

Railway over the Frith of Tay is so constructed that the trains are run upon it from the rails of the line on one side, and run off from it on to the rails of the line on the opposite, without any hindrance or inconvenience to passengers or goods; in the fair season such a Railway vessel, propelled by powerful steam-engines, might no doubt cross the harbour of Bombay to Inora Bunder; but in the monsoon it is a question which must rest with those intimately and practically acquainted with the harbour, whether there would be a possibility of the passage being, not slightly impeded, for that would not be of much consequence, but altogether prevented. But this much may be said, that during the monsoon the transit of heavy goods will be comparatively small even on a Railway, and there is no doubt but that a steamer with powerful engines, carrying passengers, light goods, the mail, and valuable merchandise, could always cross the harbour throughout the monsoon, and thus prevent any serious delay.

In addition to the advantage of direct distance, the Inora Bunder line has this in its favour, that Cotton and all goods or produce brought to Bombay for exportation, would be landed close to the presses, or warehouses, where they are to be stowed; whereas, by the Tanna line, if the terminus is at Byculla, near the Race-course, all goods, produce, &c., will have to be carried three miles from the Railway terminus to the presses, or warehouses, where they are housed previous to shipment, thus entailing a considerable expense of transit; and if the Railway terminus is made near the wharves or warehouses, the Railway must pass through the most crowded streets and thoroughfares of the suburbs of Bombay, against which there must exist a strong objection.

So much for the import produce. And, as regards the exports, the case is quite as much in favour of the Inora Bunder line. All piece goods, all English ma-

nufactured articles, iron, &c., and *dates*, which of themselves compose nearly one-fourth of the whole exports in weight, would be sent with less expense from Apollo Pier than from the terminus at the Race-course; and, as regards salt, the next chief item of export from the Concan to the interior, it will be found by the tables in the published papers relating to the Great Indian Peninsula Railway Company, that the salt produced in Carranja and Sanksee alone, amounts to about 50,000 tons, and as Bombay could receive its supply of salt equally well from Salsette and Panwell, &c., as from Carranja and Sanksee, the whole of this quantity would be available for transit into the interior by the Railway in its immediate vicinity; whereas more than two-thirds of this salt would require to be first carried to the Callian Rail at a certain cost; so that in the important item of salt-traffic, the line by Inora Bunder would possess a most decided advantage; whilst, as regards grain, as all the grain from Candeish can be much cheaper conveyed by the Thul Ghaut to Bombay, than by the Malsej line, there can be no doubt of the Inora line at least equalling the Malsej line in the transit of this item.

By the Tanna line the first twenty-two miles of rail reaches to a spot from whence there is now a most convenient and economical carriage by sea, and therefore as regards heavy goods, this first twenty-two miles of rail may be considered as of little, if of any value.

It has been supposed that the Railway passing through Tanna would greatly improve the property on the island of Salsette, and there is no doubt but that it would do so; but it would still more improve property on Carranja, an island as large in area as that of Bombay, and offering most eligible elevated sites for residences, which a constant, certain, and easy communication by the Railway steamers or floating bridges would bring within less than an hour's transit of Bombay, or little more than the time now occupied by many

officials and others to reach their offices in the fort; in fact, the island of Carranja, from its position, and from its elevated land, offers a much more desirable retreat from the fatigues of office, than does any part of Salsette. And there is besides a large and important trade by Nagotua, and from the southern Mahratta country, or southern parts of the Deccan, by Mahabuleshwur, that would be brought to the Inora Passage, and so swell the profits of the Railway Company; a trade that does not admit of any exact computation, but which, it is believed, would be found of great importance, as, in fact, by this Inora Passage, a new country, or all that from Carranja, by Alibaugh and along the foot of the Ghauts to Nagotua would, as pointed out by Captain Graham, in the report previously alluded to, be opened up and brought into immediate contact with Bombay.

The advantages and disadvantages of the Inora Bunder line have now been fairly stated. The advantages are numerous, the disadvantages are all composed in one item—the crossing of the harbour, or a passage of six miles of water.

The state of the facts of carrying the line by Tanna would stand thus:—From the terminus at or near the Race-course at Byculla, in Bombay, to the Sungum at Poona, going round by Tanna, and joining the present Panwell and Poona mail-road, about six miles from Panwell, would be at most 105 miles, on the supposition that the line is carried by Poonorolee and not by the Dapooree road, as has also been calculated; for in the Inora Bunder case, there would thus be an excess of actual distance from Bombay to Poona of twenty miles, and an excess of Railway of twenty-six miles over the Inora Bunder line. Say that this extra twenty-six miles required one hour for goods, and fifty minutes for passenger trains to accomplish, it is probable that the time of crossing at the Inora Bunder, including the running of the trains on and off the floating Railways or

vessels, would occupy this time, so that as regards time there would be no saving, excepting that from the terminus at Byculla to the fort of Bombay.

Next, as regards expense, twenty-six miles at $2\frac{3}{4}d.$ per ton per mile, is $5s.\ 11\frac{1}{2}d.$, against which is to be set the interest on the money expended on the bunder and piers at Inora and Bombay, the establishment required at Inora, and the expense of cost and working of the floating Railway or steam-vessel across the harbour, items which we have not the necessary data for calculating.

But supposing the objection of any impediment to the passage of the harbour being got over, there still remains a point to be considered, namely, the working of the electric telegraph, which it is understood is made a *sine quâ non* of the introduction of Railways. Now, by the Tanna line, the wires could be laid complete and unbroken to Poona, but by the Inora Bunder line, the communication could only commence from Carranja. From the Council Board or Post-office then, the difference would amount to this,—the conveyance of a message from either of these places to the terminus at Byculla and to the terminus at Inora Bunder, a difference of time varying from half to three-quarters of an hour, provided a steam-vessel was always at hand to take over such message. How far this is an objection can now be judged. (*See* Appendix F.)

With the terminus at Inora Bunder, of course all the workshops, engine-houses, sheds, &c., would be at Inora, which, from the facility of landing all stores from England immediately on the works, instead of having to carry them to Byculla, would be a certain advantage, and there are no disadvantages attending the establishment of snch workshops, &c., at Inora. Bombay would certainly lose the pleasure of its Railway; but it would also lose the chances of accidents from its passing through a crowded thoroughfare.

There appears, therefore, everything in favour of the

line by Inora Bunder, with the exception of a crossing of water six miles in breadth, and how far this is a sufficient objection to invalidate its other claims for preference can now be judged.*

But allowing the Inora Bunder line to be rejected, it would in no way negative the proposition of making Poona the first terminus from Bombay, as it has been already shown that a Railway would reach Boorhanpoor to the north-east, and Seroor to the south by a less distance, even *coming round by Tanna,* than it would by the Malsej Ghaut, so that there can be no occasion for going over that ground again.

As for any difficulties on the proposed line by Poona, Seroor, Ahmednuggur, Aurungabad, and the Adjunta Pass, to Boorhanpoor, a brief description of this line may best serve to show what they are. From Bombay by Tanna to the Panwell and Poona road, and by the Apta valley to Capoolee, at the foot of the Bhore Ghaut, there are no difficulties, as was shown in the proceedings of the Committee appointed to examine into the merits of Mr. G. T. Clarke's originally proposed Railway by this line (the road up the Bhore Ghaut we leave for the present). From the summit of the Ghaut to Poona, soon after quitting the neighbourhood of Khundalla, there is nothing offering any obstacle; the line

* One very material point in favour of the Inora Bunder line has been overlooked, to which the attention of the author has been directed by a friend, and which is the very great pressure which Government will have to sustain in purchasing ground for the Railway in Bombay. Every inch of private property through which the Railway passes will have to be paid for by Government at a valuation price, and which probably will cost, where properties are so valuable, something exorbitant. Even with the terminus at Byculla the purchase of private property will amount to a very large sum;—but if, as has been stated, it is proposed to have the terminus near the Cooperage, at the extreme verge of the Esplanade, the purchase of the ground through the Native Town will be a formidable item; whilst the inconvenience, not to say danger, of carrying a Railway through a native town and densely populated district, and along the whole length of the Esplanade, will be very great, even should the line be carried along the sea-shore. By crossing to Inora, in Corruyah, all this expense, danger, and inconvenience would be saved; whilst the crossing of the Friths of the Tay and Forth in Scotland, show that a narrow sea-channel is no absolute impediment to a line of Railway.

would take the old direction by Poonorolee, crossing there the Moola river on a very rocky and favourable bed, and proceeding to the Sungum at Poona by a perfectly easy country. The Sungum should, on every account, be the terminus of the Railway, from whence the extension would be carried across the Moola river towards Seroor, whilst the communication by omnibuses and vans would be kept up with Dapoore, Kirkee, and the city and cantonments of Poona.

From the Sungum to Seroor, after crossing the Moola river, which has high banks and a rocky bed, some hard, undulating country is at first met with, but offering no particular difficulty, and the remainder of the line would be sufficiently easy, the Beema river being crossed at Korehgaum; from Seroor to Ahmednuggur the Goora river is crossed, and some undulating ground occurs, and one or two smaller streams; but the greater portion of the road would be over a hard level plain; just before reaching Ahmednuggur the Seena river must be crossed, a tolerably broad, shallow river, but perfectly dry, except during the monsoon; so that up to this point there is nothing in these seventy-two miles requiring more than the ordinary labour of a Railway.

From Ahmednuggur to Aurungabad, seventy miles, the greater portion of the line would run over a beautiful level plain, the only difficulties consisting of a small Ghaut, about twelve miles from Ahmednuggur at Imampoor, or Mimbeerwarree; but the line might be carried over this pass without any material difficulty, as the country is smooth, though undulating. At Toka, forty-nine miles from Ahmednuggur, the Godavery river has to be crossed and the Nizam's dominions are entered. This river, which is broad but dry, except in the monsoon, and the Imampoor Pass, are the only at all expensive operations in these seventy miles, which is otherwise particularly easy, and admitting of economical construction: there is now a driving road for carriages, and has been so travelled by the author.

From Aurungabad to the pass of Adjunta the distance is about fifty miles; about twelve miles from Aurungabad a small range of hills is passed by following the course of a small stream; the remainder of the road is nearly level, partly over somewhat soft, partly over hard soil, but presenting no difficulties whatever: one small, but rapid river, the Poorna, occurs in this portion of the line: immediately in the vicinity of the Adjunta Pass the ground is hard, stony, and undulating, but not to any serious extent.

From the Adjunta Pass to Boorhanpoor is a distance of seventy-one miles by the present track; but as some of this is very tortuous, the distance by rail would be less. The Adjunta Pass is about one mile in length; the present road through the pass is very steep and rocky, but the formation of the ground admits of a very good line being selected, and with curves of considerable radius. The remainder of the country to Boorhanpoor is hard and good, presenting no difficulties; the ground sometimes undulating and hard and stony, at other times of a softer soil and level, but in no instance presenting obstacles of any magnitude, except the river Taptee, which must be crossed to reach Boorhanpoor, which is on its north bank, whatever line is taken from Bombay. There are, of course, several nullas and small streams on this line; but no other river of any size, though there are one or two which give passage to a good deal of water in the rains, the principal of which, the Poorna river at Edulabad, might be avoided by crossing the Taptee below the junction of that river.

The whole line from Poona to Boorhanpoor, by this route, may therefore be safely considered as a very fair line; there are one or two large rivers to be crossed, and three small passes to be surmounted, but the remainder of the line is probably as easy and inexpensive as any equal distance in India, having the advantage of being hard and well drained, and being a fine open country. At Toka, on the Godavery, the Nizam's territory is entered,

and the line continues in it as far as the Adjunta Pass, between which and Boorhanpoor a small patch of the same dominions is also crossed, the line altogether passing through about eighty miles of that state. But if ever a comprehensive system of Railways is to be carried out in India, the friendly native states must be passed through, and probably there is no native power that is so closely connected, and assimilates so nearly to our own as that of the Nizam's; besides which, one great source of expected emolument to the Railway, and of good to their mercantile interests, is the conveyance of the Oomrawutty and Berar Cotton, the produce of native states, and, therefore, so far from its being an objection to the line that it passes through a portion of a native state, it is in reality a great advantage, as opening up these very states, and bringing them within the influence of the Railway,—thus both receiving and conferring benefits.

It would be impossible to desire a more direct line than that from Poona to Boorhanpoor, which for 260 miles has a general direction of nearly north-east, in as straight a line as could be drawn upon a map; whilst the general direction of the line from Bombay, or Tanna, through Poona to Sholapoor and the southern districts, is also very direct; so that Poona appears to be decidedly the point from which the lines should bifurcate, unless it is thought better to take advantage of the line to Seroor, by which less *new* line would be required, though at an increase of twenty miles of direct distance.

With respect to the ascent of the Bhore Ghaut, the present road is certainly not a good one, but there is no doubt but that road, on a slope of one in twenty, could be made down this Ghaut, by taking an entirely new line. For the present, certainly the expense of constructing such an inclined plane as would admit of being worked by stationary engines, should be avoided; and it is extremely doubtful whether the advantage of using steam-power for the ascent of the Ghaut will ever

be commensurate, not only with the great expense of first construction, but of the constant cost of working it. It has been shown that on the Thul Ghaut, the labour of ascending and descending this Ghaut is supposed to be the same as that of travelling the same distance on the plains, the ease and quickness of the descent making up for the increased labour of the ascent; and it has also been shown that on a paved-line, or on tram-lines, on this Ghaut, the advantage will be still greater. The expense, therefore, of ascending and descending the Ghaut will counterbalance each other; whereas, on the Malsej, a double rate was to be taken for ascending the Ghaut,—that is, $5\frac{1}{2}d.$ per ton per mile, or $8\frac{1}{4}d.$ per ton per mile, for the ascent and descent; but by cattle draught up a tram-line, the charge would only be $2d.$, or, at most, $3d.$ per ton per mile of ascent and descent; so that, in point of expense, the Cattle-draught Ghaut is infinitely preferable to the Steam Power, and, as regards time, the advantages will not be found so great as might at first be supposed. For, let the Ghaut-road be six miles in length, and of such a slope as the Thul Ghaut—or even on an average of one in twenty—four horses, with a light omnibus, would trot up such a road, if changed half way, with ease, and would perform the distance, including changing, in one hour; and this might be done at a charge of two pence per passenger per mile, or one-third what the price would be by steam-power. Now, it is very doubtful whether, up such an incline, the trains drawn up by a continuous rope would ascend much quicker than this, including the changing from one stationary engine to another: or, suppose they did it in three-quarters of an hour, which would require a speed of ten or twelve miles an hour, one *quarter* of an hour would be saved, which is surely not of sufficient importance to warrant such an expenditure as an inclined plane for steam-power must demand, particularly as this Ghaut only occurs *once* between Bombay and the interior of India. For goods, the gain, in time, might be one hour

and a-half, which would still less justify the extra cost of transit, which is more than double that of cattle-draught. The wear and tear of six miles of rope, or twelve miles for a double line, would be very great, and a constant expense, as would be the machinery, stationary engines, &c.; and, therefore, as prudent men, as a Company constructing a railway for the sole purpose of returning a profit for the capital expended, the Great Indian Peninsula Railway Company will be very wrong to sacrifice so much as the Malsej Ghaut line demands merely for the purpose of obtaining a straight incline, up which trains may be brought by steam-power, to accomplish which requires no less than 3,981 yards of tunnelling, at an expense of upwards of £250,000; whereas, by adopting the Ghaut lines for cattle-draught, no tunnels need be excavated, as sufficiently easy curves for the passage of such a train can always be secured without resorting to such an extremely expensive expedient.

From all the above considerations, the author is decidedly of opinion that the ascent of the line of Ghauts separating the Concan from the table-land of the Deccan, should be accomplished by cattle-draught, and not by steam-locomotion of any kind.

The line by Poona, making that station the first terminus, appears then to offer every advantage that could be desired for the experiment of the first introduction of Railways into India, as by an expenditure of little more than 100,000*l.* a really useful and paying line would be made complete in itself. One of the largest native cities, and the most important military station in Western India, would be at once connected with the capital of the Presidency. Such a complete line would offer the very best possible opportunity for testing the adaptness of steam Railways to Indian wants, for not only is Poona on the direct line for the transit of the produce of the country to Bombay, as the 40,000 tons annually carried by the Bhore Ghaut sufficiently proves; but comprising

within itself a large military cantonment of European troops, a large and populous native city, the seat of Government, and of the head-quarters of the army for four months of the year, the residence during that period of an extensive European community, it offers every facility for trying the real value of a Railway in the carriage of small but valuable parcels, European stores, the conveyance of troops and passengers, and the mail, the transport of the luxuries of life, such as fish, fruit, vegetables, ice, as well as live stock for the Bombay market,—the value of Railway communication for all these purposes, as well as for the transit of the mere produce of the country, would be immediately shown. Whereas, by adopting the Malsej Ghaut line, it would take years and years, before, running through a country devoid of large cities or cantonments, or the residencies of a large European community, it could in any way develope the probable adaptation of the system to our Indian empire.

Should it be advanced that if, as has been shown, heavy, bulky articles, as the raw produce of the country can be carried by cattle-draught tram-rail at a much lower rate than they can be by steam-power, that we have no more right to force this steam-locomotion transit upon one district than another, it must be replied that whereas in Candeish the only transit required is that for produce or merchandise, it would be most unjust to force an uselessly expensive transit upon the country; but where the line of Railway is so laid out as to pass through or near as many large cities and cantonments, as is compatible with a generally direct communication through the country, so that the community in general will derive all the advantages arising from speedy communication, as well as the regular and economical transit of merchandise and the raw material, that in such case the lesser good must yield to the greater, and the mere goods tram-line must give way to the universally applicable steam-locomotion line, as

both cannot exist, as has been the case in England, where 16,000,000 of tons of heavy goods, &c., are now carried by rail at a higher rate than the same could be conveyed by tram-lines worked by horse power (*see* Appendix B); but if the line were carried by the Malsej Ghaut, in a direction where it cannot possibly be of any use, except in the transit of heavy and bulky goods, then we have no right whatever to make the grower, producer, or consumer pay three times as much for sending his goods by steam-rail as he could have them conveyed for by cattle-draught on tram-lines, at a speed quite equal to the requirements of the transit of such produçe or goods. Where a monopoly of transit is imposed upon a country, the powers who impose such monopoly are bound to consider the good and claims of the inhabitants of that country, as much as the interests of the proprietors of the monopoly they give their sanction to.

Enough, therefore, has, it is hoped, been shown, to induce the Indian Government, with whom the power of deciding on the main direction of the Bombay Railway still rests, seriously to consider what has been here advanced, and to take into mature deliberation the very great advantages that would accrue from completing a line of Steam Locomotion Railway *at once* to Poona (as stopping half way would ruin everything), so as really and truly to test the merits of the system.

In deciding upon this point, as well as upon the description of Railway to be finally introduced into India, the Indian Government have three main points to consider,—first, what will confer the greatest benefit upon the country and upon its inhabitants, upon whom a *monopoly of transit throughout their country* is about to be forced. Secondly, that such a system and such a direction of the line shall be selected that shall offer every prospect of rendering a fair return to the proprietors of the enterprise; and, thirdly, that as without the liberal aid and assistance of Government the Rail-

way could have no existence, care should be taken for the protection of their interests, in so arranging the general direction of the Railway as to be of advantage to their large military cantonments, so as to assist in the transit of military stores and in the transport of troops, for which purpose the lines should pass through as many military stations as possible, so as to admit of an immediate concentration of troops in case of necessity, and that these connecting lines should be continued to Bombay, by which, in case of any emergency requiring the assembling of a large body of troops at the Presidency for the purpose of embarkation for foreign service, or for any other reason, they could be brought within the smallest possible time from the various stations connected by the line of Railway: and hence the great advantage of the Poona Line, with its extension to Seroor and the head-quarters of the artillery at Ahmednuggur, and eventually to Sholapoor, whilst Sattara is within a short distance. Thus, by this chain of Railway, a vast number of troops, European and native, and of all arms, could be assembled at Bombay within a very short period. This would really be making the Railway subservient to the protection of the country, whilst at the same time both the interests of the proprietors, the claims of the merchants, and the convenience of the community generally, would be considered.

From the papers illustrative of the prospects of the Great Indian Peninsular Railway Company, printed in Bombay in 1846, it would appear that the whole of the proposed line for which the estimates have been prepared, is intended to be a *single* line, no allowance having apparently been made for converting it into a double line on any future occasion; but to carry the 180,000 tons of goods per annum calculated for by Mr. Chapman, would require more than a single line. It has been before stated, that in England, out of sixty-three Railways, only twenty-four carried more, or so much, in 1847, as 180,000 tons of goods, and yet all these are double lines,

and many of them, such as the London and Brighton, the South-eastern, the Eastern Counties, the London and South-western, are first-rate double lines, using the largest and most perfect engines, with a most numerous, efficient, and expensive working establishment, and conducted with all that regularity and interior economy of management, that can only be perfected after a considerable time, even in England, much less in India, where, to give transit to 600 tons a-day for 300 working days on one Railroad, would require an amount of establishment and system of management that we are little prepared for. True all these lines are greatly employed in their passenger-transit, although one-third the revenue of the greater number of English Railways is now derived from the transport of goods; and, besides, all these lines run by night as well as by day, which cannot be attempted in India for many years to come, unless the system of continuous raised viaducts proposed in this Essay be adopted.

Where the traffic is great, and the *distance* considerable, or for any great length of continuous line, the delays caused by a single line are very great: for *short*, branch-lines they answer very well, running backwards and forwards; but for long lines the disadvantages of single lines for steam-locomotive transit are too obvious to require further elucidation. In constructing the first lines of Railway, then, in India, arrangements should be made for adding a second line at any time, if the expense of a double line would not be sanctioned at once. On the viaduct system now proposed, this can easily be accomplished, as has been shown, and a second line of rails be added without in any way interfering with the traffic on the rail, and at a very trivial extra first outlay, only 1000*l.* per mile, which is one of the advantages of this system.

It has been stated in the public prints, that rails of *eighty-four pounds to the yard*, are to be laid down for the Indian Railways; such heavy rails implies

the use of the heaviest monster engines, which, it cannot be too often repeated, are totally unsuited to this country, where we must have an engine under command, and not running through houses, tramping down grates and fire-places, crushing furniture and kitchen utensils, and killing people sitting by their own fire-sides. We require a practical, working, paying Railway, not a show one; we do not wish to know who can build the largest engine, or draw the heaviest train; we have no object in ascertaining the utmost limit to which the pressure on the rails can be extended without actually crushing the metal. A good serviceable line, constructed for the passage of numerous light engines and trains, is what is not only best suited, but is the only system of steam-locomotion that can ever answer in India; and this we can have at a moderate cost, and without endeavouring to imitate the extremes to which everything connected with the system has been carried in England; and with what result, let the price of Railway shares answer.

Should the viaduct system now proposed be adopted, the whole line from Bombay to Poona, leaving the road up the Ghaut for the present, might be completed in two years; but it would be very long before a line of high earthen embankments would be sufficiently firm to admit of the passage of a train, and to retain the level of the rails during the four months of the year that they are continuously subjected to constant heavy rain, and which the experience of our common road embankments, when of any height or carried across wet ground, too clearly shows, will require a very long time to consolidate sufficiently for Railway purposes, all of which is at once avoided by the viaduct system.

And as the great object should be to complete a line between two main points, such as Bombay and Poona, with as little expense, and in as short a time as possible, the whole of the money should be expended

on the line of rail, merely constructing *bonâ fide* temporary station-houses, work-sheds, engine-rooms, &c., and employing every man that is to be had, and every rupee that is to be expended, on the construction of the line itself, the terminus buildings can be erected when experience has shown the nature and extent of the buildings required, so that these great works at the terminus stations may not require to be built over again to meet the increasing demand for room and convenience ; and when the profits arising from the early completion of the line from point to point, shall have provided funds for constructing these terminus stations on a scale commensurate with the traffic.

In conclusion, the Author would advocate the immediate construction of a line of Railway suited for steam-locomotion, from Bombay to Poona, complete, either by the Inora Bunder, and line of road proposed by Captain W. D. Graham, of the Engineers, or round by Tanna, whichever may be considered as offering the greater advantages; that this line of Railway should be so constructed at first as to admit of a second line of rails being added at any time, without interfering with the traffic on the line; that the whole sum on which Government will allow their guarantee, should be expended on the actual construction of the line, merely erecting such *bonâ fide* temporary buildings as are necessary as preservatives from the weather; that the line up the Bhore Ghaut, or up the line of Ghauts in its vicinity, should not be attempted at present, unless funds can be spared for the purpose; and that, at all events, it should be adapted for cattle-draught up a tram-line, and not for an inclined plane to be worked by stationary or other engines ; that serious consideration should be given to the adoption of the raised viaduct system herein proposed, as above all others peculiarly suited to railroads in such a country as India, particularly in the districts, and by which the line between Bombay and Poona might be in operation in two

years after the commencement of the work; that all monster engines, and their necessary adjunct, heavy rails, should be avoided, and a system of light *paying* engines and trains adopted.

During the construction of the Bombay and Poona locomotive steam line, the tram-line for cattle-draught from Tanna to Nassick, by the Thul Ghaut, might be undertaken, so as to have both lines in operation at once, thus affording the very best possible test of the adaptation of the respective description of lines to their several purposes, and one general system of control and management and engineering superintendence would answer for both lines during their construction.

By thus combining all the advantages of the quickest mail and passenger trains, on a scale quite equal to the demand, with the steadiness, regularity, and economy of a system of light train-goods traffic, with a system of tram-rails for cattle-draught for those districts where such a line only would be applicable, the Great Indian Peninsula Railway Company will meet every required contingency, and the Government, without whose liberal aid and fostering care the Railway could have no existence, would be among the first to benefit by the vast scheme of social improvement, that by their means is about to be introduced into the country over which they rule; and there can be but little doubt if proper exertions are thus made to demonstrate practically the actual benefits of Railway communication in India, and the profitable nature of the enterprise, that Government will so increase the present guarantee as to secure the first constructed line being complete in itself; whilst it is fully believed that by avoiding, at first, all great obstacles, entailing an enormous expenditure, and by a proper development of the system, so as to meet all demands for the transit of the mail, of passengers, and light, and valuable, and perishable articles, as well as of heavy goods, no further guarantee from Government will subsequently be required; but that capitalists, both

native and European, will only be too glad to invest their money in the undertaking, and once let the English merchant acquire a pecuniary interest in the advancement and progress of civilisation and the arts in India, and depend upon it he will not allow his money to lie idle, or the value of his property to diminish, for want of energy and exertion, skill and enterprise, but the vast resources and fruitful soil of our eastern empire would spring into astounding growth and fertility, under the fostering care of British commercial enterprise.

POSTSCRIPT.

At page 89, it has been stated that the reasons for selecting the Malsej Ghaut line had not been made public; but since the foregoing pages were sent home for Publication, the Author has been favoured with a copy of the letter from the Chairman of the Great Indian Peninsula Railway Company to the Government of Bombay, bearing date June 6, 1846, printed for the use of the Company, and in which the reasons for selecting the Malsej line are given. These reasons appear to be—that as no *break* ought to exist in the line, this can only be avoided in the case of an island like Bombay, by crossing at Tanna, where the water separating the island from the mainland is the narrowest; that the great expense of surmounting the great Syhadree range demanded that this ascent should only be made in one spot, and that the peculiarities of the ground at the Malsej Ghaut offer greater facilities at that point than at any other along the range, near the latitude at which, from other causes, it is desirable that the line should enter the Concan from the west.

In how far this Malsej line answers these requirements, the reader has had an opportunity of judging, every point above adverted to having been anticipated in discussing the merits of this line: but there are some parts of the letter in question which it may be as well more particularly to analyze. It it said that the advantage of Railway transit, even in cheapness, over every other mode of conveyance at present in use in this country, will render it perfectly safe to adopt for the Railway, routes which are somewhat longer than those

now used by bullocks and carts. On this mistaken impression the whole argument in favour of the Malsej line has been founded, and a system recommended that could not on any other grounds be for a moment entertained, that system requiring a monopoly of transit throughout the country, everything being made to give way to the necessity of concentrating all the traffic on one point, and that point the Railway terminus at Alleh.

That such a system of monopoly is contemplated by the Directors of the Company may be gathered from the two facts on which it is said it has been possible to devise a system of Railways which offers a sufficient inducement to capitalists to venture on its construction; the first being that the traffic comes in a great measure *through* the districts intersected by the Railway, and not *from* them; and the other and principal fact, that the traffic of many and great countries, each contributing a part, is concentrated on one line; and that should the Government permit this latter principle to be violated before the operations of the earlier lines have developed the resources and traffic of the country, it will do much towards destroying the prospects of the present undertaking; or, in other words, that Government must so arrange that the lines of traffic throughout the country shall be made subservient to the interests of the Railway.

This fact is put still more clearly in another part of the letter, in which a great north and south line of communication is supposed to be carried through the country eastward of the Ghauts, or Syhadree range, all the traffic on which is to meet and concentrate at Alleh, for conveyance to Bombay by the Malsej Ghaut line, so as to afford the greatest return to its proprietors, and the greatest advantage to the commerce of Bombay.

Now, if all this could be arranged without inflicting manifest injury upon the growers of the produce and inhabitants of the country generally, well and good; and if the cheapness of transit by rail was really so great as

pre-supposed, as to admit of longer routes being taken than by the present roads, such might have been effected; but it has been shown in the text of this Essay, that the *facts* are against this assumption. Mr. Chapman took the cost of conveying produce, &c. over roads that are mere cleared tracks; whereas, had he taken the cost of transit on the grand trunk-road in Upper Bengal, or even on the best and only bridged and metalled roads on this side of India, the result would have been very different, as has been shown in the previous pages of this Essay.

This great north and south line, which the Malsej Ghaut line is to join at right angles, and receive all the traffic from the north and south, is on the north of the new Thul Ghaut road only about thirty miles distant; and it has been shown that the produce of Candeish and heavy merchandise could be conveyed to Bombay by this Ghaut by a line of plate-rail, worked by cattle-power, for *one-third* the cost of carrying it by steam locomotion on the Malsej Ghaut line, and even on common roads at a cheaper rate; and that by this Thul Ghaut no less than 50,000 tons of goods passed in eight months and a half of this year, all of which must be monopolised, at a great loss to the natives, for the Malsej line, to enable the latter to pay.

On the south of this junction of the Malsej line with the great north and south line lies the Bhore Ghaut, down which upwards of 40,000 tons of goods are now annually conveyed, which are also required by the Railway to abandon this Ghaut and go on to their line to enable it to pay a dividend (*see* Appendix D).

But it has been shown in the text that goods can *now*, on the present roads, be conveyed to Bombay from Poona by this said Bhore Ghaut for 1*l.* or 1*l.* 4*s.* per ton; whereas it would cost 1*l.* 13*s.* 6*d.* per ton, to convey the same goods by rail from Poona to Bombay by the Malsej Ghâut line, or at least 9*s.* 6*d.* per ton *more* than by the present mode of transit; and from Ahmednuggur,

which is also one of the intended feeders of the rail, it now costs 2*l*. 1*s*. 6*d*. to carry a ton of goods by the present roads to Bombay by Poona; whereas it would cost 2*l*. 7*s*. 10*d*. to carry them by the Malsej line, joining the proposed Railway at Seroor, or 6*s*. 4*d*. per ton *more* than by the *present mode* of transit. About 100,000 tons of goods that now pass by the Thul and Bhore Ghauts must then abandon those Ghaut roads and be drawn to the Malsej line, at a great loss to the natives of the country, as well as to the Government, so as to afford the greatest return to the proprietors of the Railway.

This is looking on the Railway merely as a means of conveyance for heavy goods, and the produce of the country, which is all the Malsej line can ever be; but the case is very different when the universal application of a Railway is considered as in the Poona line, which it is said in the letter under notice would now be evidently a losing enterprise to its proprietors; but *why* it would be a losing enterprise, whilst the Malsej line is a profitable one is not stated; but that the very reverse is the case, is shown in the text of this Essay.

It is also stated that although the Malsej line does not actually pass by Poona and Ahmednuggur, the approach to them is much facilitated; by how much is seen above; and that a branch to Poona may eventually become part of a new trunk line, with how much benefit has been shown in the previous pages; it is also stated that the proposed system of lines by the Malsej Ghaut, in its earliest and least expanded state, will greatly improve the communication between all the military stations of the Presidency; but how it is to do this, is not mentioned, nor is it at all apparent, considering that in 360 miles the Malsej line only passes one station, composed of a wing of a regiment of Native Infantry.

Although, then, the Author had not an opportunity of knowing the reasons on which the line by the Malsej Ghaut were decided upon when discussing the subject, he believes it will be admitted that he has in the text

fully anticipated all the advantages advanced, and shown them to have been founded upon a false basis, whilst the facilities of the line are less encouraging than has even been supposed in the text of this Essay; he can, therefore, with increased confidence leave the matter in the hands of those in whom the power rests to decide the question of the best first inland terminus.

DEC. 26th, 1849.

APPENDIX.

A.

As the viaduct system now proposed could never be carried into effect, unless its cost can be kept within certain limits, it is thought better to give the calculations on which the principle is founded, in detail, so as to enable the reader to judge in how far the author is justified in estimating the cost of such a system at the rate he has given in the text.

These viaducts are to consist of a species of trussed framing, composed of teak timber and wrought iron, the struts and compressed parts being of wood, and the ties or parts subject to a tensile strain of wrought iron, the whole arranged on a system of diagonal framing — *vide* annexed Plan. There is, however, one great peculiarity in these bridges, which it is believed has not been attempted before, namely, that although the framing of the truss is in itself as strong and stiff as any such framing can be, or as the framed American bridges are, the power of the bridge, however, is not allowed to depend upon the mere strength of the framing, which from forming a straight line must be subject to all the disadvantages of the *girder* system, the transverse strain on which, in large spans, is so great as to require an immense mass of material to overcome it. To avoid this great strain on straight girders the principle of the arch has been successfully adopted, and the viaducts now proposed will be found to contain all the advantages of the arch with a less expenditure of material, by using an inverted arch or three sides of a polygon of wrought iron bars, in the place of a cast or wrought iron tabular arch, which, subjected to

pressure or compression, must have its strength proportioned to its length or span; whereas, by inverting the principle, and subjecting the iron supports to a tensile strain only, the span has no effect beyond that of the actual additional weight of load, provided the ties have no weight of their own to support.

The action of this principle will be seen at once by a reference to Fig. 1, in which A B C D are bars of flat wrought iron, so supported by the framing of the bridge as to be subjected to no strain from their own weight, and which are connected together by the horizontal bar B C. As a weight acting at B is supported by direct tension on the line A B, and by direct tension on the horizontal line B C, or by a thrust on the line B I against the pier, it is clear that the part C cannot be drawn towards the pier I, without the part C *rising* so as to allow D C I to be drawn nearer to a straight line, and such rising is prevented by the simultaneous pressure on the point D, as well as by the stiffness of the framed railroad or girder. If the load is placed on the centre portion of the bridge the strain bears directly upon the two ties, A B, C D; and for a railway train, it is taking an impossibility to suppose all the load to act only on one point, although the construction of the viaduct is proof against such an action as above shown. At the joints B and C, iron stirrups are fixed, which passing under the framework of the bridge, support its whole weight upon the ties A B, C D. The upper ends of these ties pass over small iron saddles, as shown in the Plan, and are thence continued to an adjoining span, which may in this manner be carried for miles, one span supporting the other.

If the Plan be inverted, it will be seen at once that the lines A B, B C, C D, form the lines of resistance to pressure of an arch or of a polygon of pressure; but the lines A B, C D, if thus acted upon by *pressure*, would require to be, from *their length*, of very considerable scantling; whereas, subjected, as they really are, solely to a *tensile* strain, a comparatively small section suffices.

For a single span of this description, or where the viaducts

join on to the embankments, it is necessary to fasten the ties A B to back ties, or chains fastened into masonry, in a similar manner to the chains of a suspension bridge.

As these ties A B, C D, are *straight* lines, they cannot alter their form, unless by extension or fracture from an overpowering strain; but as the strain on the ties is exactly in the direction of their length, and precisely proportional to their angle of inclination, it is most easily calculated, and an ample strength secured.

This then is the principle on which these viaducts are proposed to be constructed. The framing is of itself as strong and stiff as any framed girder-bridge can be, and which has been found perfectly suitable for railway traffic; but by means of the suspension ties the strain due to the span is entirely taken off, and all the advantages of the arched system secured, with a smaller requirement of material.

An inspection of the Figure will show this. In a common framed bridge the load would produce a transverse strain, proportional to the span or length of the girder, and which requires great strength in the various parts to resist; but in this system the points *B C* are evidently supported directly on the small piers A and D, thus at once reducing the span of ninety feet to the centre division of thirty feet. But by using wrought iron diagonal ties instead of wooden struts, this thirty feet is again reduced to ten feet, as any weight placed on the centre portion, E F, is sustained directly by the ties E G, F H, acting on the supported points, B C, by vertical pressure on the posts G B, H C, so that the unsupported length is reduced to ten feet; but this is again reduced to five feet by the vertical rod and struts, shown in the Plan. Thus every portion of the bridge is immediately supported, and therefore requires only such a strength as shall be sufficient to sustain the load due to the fraction of the bridge it actually sustains; whereas, in a common framed bridge the road on the *whole* bridge acts upon every portion of it, as in a girder.

The only other point to be secured, was the stiffness and

freedom from vibration, so absolutely necessary in a railway bridge, and a means of preventing any such action or working of the points or screws as should in time loosen the structure; this has been perfectly accomplished by the diagonal ties, which are so arranged as to admit of being screwed up to any degree of tension, after which the strain is taken off the screws, so as to prevent any working, whilst the whole framing can at any time be again screwed up, should it require it.

This desideratum may be obtained in various ways; but for a combination of wood and iron, the method shown in Plan, figs. 5, 6, is probably one of the most simple and efficient. The upper stirrup, *a*, is made thick at the top, so as to give a firm bearing to a strong screw bolt passing through it, and acting upon an iron plate laid on the surface of the top rail, by turning this screw the bolt *b*, which works in a loose hole in the upright post, is drawn up, and with it strains upon the diagonal ties attached to it, which acting upon the lower stirrup by means of its bolt, tightens the whole framing, when thus the thick plate of the upper stirrup has been raised slightly above the top rail, the vacant space is filled in with thin plates of iron, thus relieving the screw from all strain, and effectually preventing any working.

The cross-girders are placed after the side framing has been put up on the piers, and then the *wooden* diagonals or struts are fixed, resting on these girders, and being screwed up by the vertical rods, bind the whole roadway and sides into one compact frame, after which the diagonals are screwed up to their proper pitch.

It has been thought desirable to use wood for the upper and lower rails, the upright posts and cross-girders of the roadway, as being lighter than iron of equal strength, and from the valuable and enduring qualities of teak timber, especially when not in contact with the ground; whilst the advantages of employing wrought iron for the diagonals of the framing, instead of wooden struts as in the American bridges, are, that in India all such framing becomes loose, from the drying and shrinking of wood exposed alternately to great moisture and to great heat, particularly that of the hot winds, and could not,

therefore, be depended upon as a sustaining power in such a system ; whereas the diagonals of eleven feet in length are far too short to be affected by the heat, neither warp nor shrink, and admit of being screwed up to any degree of stiffness after the framing is put up, or at any other time, whilst any diagonal may be removed and replaced if found faulty at any time, without difficulty or danger.

Instead of planking, it is proposed to fill in between the sleepers of the roadway with thin cast iron plates, about four inches broad, with a deep thin flange along the centre to give them strength ; these plates are laid lengthways on the viaduct, resting on the cross-girders, and are placed with a space of about two inches between them: such a flooring would neither injure by the rain or sun ; neither could they take fire from the falling of live coke from the engine. The spaces of two inches between each plate, are partly to allow of the rain, dust, &c., freely passing through, and also to *lighten* the flooring ; and as these openings run lengthways of the bridge, they would afford a track for the wheels of a train, should it run off the rail, and therefore altogether appear well suited to the purpose.

The rails are designed with the understanding of engines of moderate weight being used, and are a modification of the bridge rail, but so arranged that the whole under surface of the rail shall rest upon the sleeper, so as to give as much bearing surface as possible. Fig. 7 shows the rail on a large scale, which is endeavoured to be so contrived as to expose a strong and substantial bearing surface, with the smallest weight of rail, which in this instance is thirty-five pounds to the yard, approaching nearly to the slotted rail in weight ; the holding-down spikes have hammer heads, and the joint bolts are the same, the nut and screw being underneath the sleeper. This form is adopted as having all the necessary strength and grip upon the rail, requiring at the same time a narrow flange. It is to be understood that the longitudinal sleepers are made of ample strength to bear the total weight of the engine, independent of any strength in the rail itself, which is, therefore, intended solely as a bearing surface for the wheels to run

upon; but possessing, from its form, great resistance to *lateral* strain, and admitting of being securely fixed to the sleepers, without injury to the surface of the rail. That such rails would last for a considerable time may be deduced from the fact, that unserviceable rails in England, which were found to have lost two pounds per yard in weight, had only ·09 of an inch in thickness of metal worn off, and yet were unserviceable.

The main sustaining ties rest upon small cast iron saddles fitted on the top of that portion of the side rails that rest upon the piers, and as these saddles rise only two feet above the top of the rail, they admit of being easily fixed.

The viaducts are made of a clear span of ninety feet, and a clear breadth of ten feet within the side rails for a single line, which is considered quite sufficient for the engines and trains proposed to be used. For a double line, two complete viaducts, side by side, are used, making a clear breadth between the outer rails of *twenty-two feet.* This forming a double line of two distinct parts, has this advantage in India, that the piers having been built originally for a double line, a single viaduct may be put on them at first, and a second subsequently added; or one may be repaired without in any way interfering with the traffic.

The piers are proposed to be built of brick, with a capping of cut stone; where stone masonry is cheap, such may be employed; but it is better to estimate for the general application of brick.

It now only remains to give the calculations for the strains and estimate of the probable cost, premising that the viaducts are calculated to bear, without any strain, a load of three-quarters of a ton per running foot for a single line, independent of the weight of the bridge itself, which, as the framing will more than support itself, will not be included in calculating the strains on the main ties.

Main Ties or Chains.

30	Feet of platform supported by chains at each end of bridge.
$\frac{3}{4}$	Ton per foot.
22·5	Tons.
3·864 =	Cosecant of 15° or inclination of ties.
4)87·14	Tons strain on 4 bars.
9)22	Tons strain on each bar.
$2\frac{1}{2}$	square inches of section required for a strain of 9 tons per square inch or $3\frac{1}{8}'' \times \frac{3}{4}''$.

The horizontal bar connecting these chains will have a somewhat less strain, or as the cotangent of an angle to its cosecant. These chains or ties are *fixed* on *each* side of *each* rail.

Diagonal Ties.

10	Feet of platform supported.
$1\frac{1}{4}$	Ton load including weight of bridge.
12·5	Tons load.
2·66	Cosecant 22° or inclination of diagonals.
8)33·25	Tons strain on 8 diagonals on both sides of both railways.
9) 4·15	Strain on each diagonal.
·46	or say half a square inch of section or $1\frac{1}{2}'' \times \frac{1}{3}''$.

The straps, bolts, and other parts are made of proportional strength, which it cannot be necessary to detail here.

Woodwork of Railings and Platform.

The cross-girders are calculated so as to bear the utmost load that can be imposed upon them, without any sensible deflection, and the rail sleepers are more than equal to the pressure of driving wheels having a load of six tons, or one pair, or three tons on each wheel.

The calculations then become:—

Iron-Work.

		Cubic inches.
8 Main chains 31′ or 372″ long by $2\frac{1}{2}$ square inches section	....	=7440
4 Horizontal chains 31′ or 372″ long by 2″	do.	=2976
72 Diagonal ties 11′ or 132″ long by $\frac{1}{2}$	do.	=4752
20 Upper stirrups 42″ long by $1\frac{1}{2}$	do.	=1260
20 Lower do. 42″ long by $1\frac{1}{2}$	do.	=1260
4 Connecting links on saddles 48″ × 2″	....	= 384
18 Vertical rods $6\frac{1}{3}'$ or 76″ long $\frac{3}{4}''$ diameter	....	= 172
Total cubic inches of iron	....	18,244
Tons in one cubic inch	....	·0001227
Total tons	....	$2\frac{1}{4}$
Add $\frac{1}{4}$th for bolts, nuts, &c.	......	$\frac{1}{4}$
Total wrought iron-work	......	$2\frac{1}{2}$ Tons.

Wood-Work.

	Cubic inches.
2 Top rails 94′ long 6″×6″	81,216
2 Bottom do. 94′ long 7″6″	94,752
20 Posts 5½′ long 7″ × 6″	55,440
40 Struts 6′ long 6″×5″	86,400
29 Cross-girders 12′ long 8″ × 5″	167,040
2 Rail-sleepers 94′ long $5\frac{1}{2}\frac{1}{2}$″ × 7″	93,060
1 Guz—Cubic inches	23,149)577,908

Total........25 Guz of Teakwood
Add ⅕ for wastage in cutting, &c. 5

Total teakwood..............30

Masonry for 1 pier or half-pier at each end.
7′ × 4′ × 12 = 336 cubic feet digging and filling in foundation.
12′×5½′× 12=792 „ superstructure of piers.

Abstract Estimate of Cost of 94 feet length of Viaduct.

	Rs.	Ans.	Ps.
336 Cubic feet digging and filling in foundation with stone and lime at 9 rupees per 100 cubic feet	30	3	10
792 Cubic feet superstructure of brick and lime at 18 rupees per 100 cubic feet	142	8	11
2½ Tons of wrought iron at 200 rupees per ton	500	0	0
30 Guz *Northern* teak at 14½ rupees per guz, inclusive of carpenters' work	435	0	0
¾ Ton cast iron plates for platform at 120 rupees per ton	90	0	0
2 Cast iron saddles 2 feet high, say ⅓ ton at 120 rupees per ton	40	0	0
	1237	0	0
Add 10 per cent. for contingencies	123	0	0
Total cost of 94 running feet of viaduct	1360	0	0

Or cost per mile..............	76,391	rupees
Two miles of rails at 35 lbs. per yard, 55 tons at 110 rupees per ton	6050	„
5 Tons spikes and bolts, &c., at 200 rupees per ton	1000	„
Total cost of one mile of viaduct railway..........	83,441	„
Or say in round numbers per mile	£8500	
Cost of a mile for a double line of rails	£17,000	
Cost of *piers* for a *double* line and *rails* for a *single* line	£9500	

These viaducts are perfectly capable of carrying engines of eighteen to twenty tons weight, and the heaviest English carriage trains; they can be constructed at any moderate inclination or depression without in any way affecting their strength, providing the piers are so arranged, that a line through the

centre of the top of the pier, and perpendicular to the inclination of the viaduct shall fall well within the base of the piers, they would thus save an immensity of labour and expense in side-cuttings through rock in ascending Ghauts.

Northern Teak is estimated for, as being quite equal or indeed, rather superior, to Malabar Teak, both in strength and stiffness, and as only short lengths of from twelve to fifteen feet are required, there is no object in using expensive Southern Teak, as logs of this and a much greater length of Northern Teak can always be obtained at a lower rate than that allowed for, of rupees twelve per guz, to which one-fifth is added for the cost of carpenters and sawyers' work, which experience has shown to be sufficient in this country, and in this case the timbers merely require squaring, and if sawed by steam, the expense would be greatly diminished.

The other rates will be found liberal and ample. With cast iron plates for the flooring, these viaducts can scarcely ever require any repair, as the iron work made up in England would be all proved before setting up, and well-seasoned Teak wood being used, nothing more than an occasional coat of paint would be required. It will be observed, that £156 per mile has been allowed, in addition to the ten per cent contingencies, which will suffice for trifling charges that are not detailed in the estimate.

Where the viaducts terminate, a mass of masonry will be required to hold the back chains; but as at these spots the piers will never be more than six feet in height, whereas twelve feet is allowed in the estimate—it not being thought necessary to make any allowance for an item that cannot be accurately known until the line is constructed — the estimated cost per mile for a single line for the Bombay Railway is £9899, so that this viaduct system will be at all events below that estimate, as £250 per mile is an ample allowance for engines, carriages, &c., which would raise the foregoing estimate to £8750 per mile, including engines and carriages.

The best description of permanent way in the cuttings and low embankments emerging from them will be, where stone is plentiful and of a good quality for the purpose, stone blocks

with longitudinal continuous wooden sleepers, laid on and fixed to them, which would give a firm continuous bearing to the rail, would admit of the *cant* of the rail being easily and correctly provided for, and would, moreover, admit of the level of the rails being corrected, owing to any sinking in the blocks, without moving or disturbing these blocks, and which is a great point to attain; whilst the timbers raised on the stone blocks being kept perfectly free from the ground, there would be no fear of their decaying, and by this arrangement the same rails might be used for the cuttings as well as for the viaducts.

It is quite clear on inspecting these viaducts that they are in fact bridges, and, therefore, that the bridging of the line would only entail such extra expense as may be due to the increased height required for the piers; and as most Indian rivers, especially near the Ghauts where they take their rise, are dry or have very little water in their beds during the dry season, there is very little difficulty in laying the foundations of the piers; indeed, one great advantage of this system of bridging, and which has been described in the treatise of which this essay was intended as the concluding chapter, is, that they can be carried across rivers of any breadth; an operation of great difficulty in India where masonry bridges are used, on account of the absolute necessity of leaving the whole water-way clear during the four months of the monsoon, an arrangement very difficult of effecting in large masonry bridges, as the piers must be finished before the commencement of one monsoon, and the arches must be completed, and the centrings cleared away and all left free before the rising of the river in the following monsoon, which does not leave above seven months to do all this in; and from the hurried manner in which long bridges are obliged to be carried on to secure the removal of the centrings previous to the rise of the river, this operation is frequently performed before the lime has had time to dry, particularly in brick bridges, and the arches have either fallen or greatly sunk or cracked; but in the case of these viaducts any moderate number of *piers* may be completed between the termination of one monsoon, and the com-

mencement of the following one, and the framed railings having been previously put together on the ground, could be hoisted on to the piers, and the whole bridge finished in a very short space of time, thus rendering these bridges peculiarly applicable to India. This principle may be carried to a span of 150 feet by having higher piers; but the ninety feet spans are more compact and answer every purpose; but in a continuous line of viaducts where cuttings or rivers may occur not exactly at the termination of a ninety feet span, this span may be reduced to two compartments, or to sixty feet, or to one compartment of thirty feet, as will be at once understood.

B.

In the foregoing pages of this essay the author has strongly advocated the desirableness of using steam-locomotion on our Indian railways; but he has done this under the impression that such railways are not merely intended for the conveyance of cotton and other heavy and bulky articles, or for the profit of one particular company; but that on the introduction of such an important innovation as that of Railways into India, the good of the community and country generally is really to be considered, and that they may be the cause of instilling the same fresh vigour and spirit of enterprise into the whole social system of this country, as they have in every land into which they have been hitherto introduced. If this is not the feeling with which the introduction of railways into India is intended to be carried out; if they are merely to carry cotton, &c., and are a mere speculation for the benefit of a particular Joint Stock Company; if they have no higher views than this, then, indeed, a system of steam-locomotion is not the one that ought to be adopted, but should give way at once to that of a tram-road worked by cattle, as is now proposed in Guzerat, where under any circumstances such a system is best adapted. The author will now proceed to

show the data on which this opinion is founded, as he does not believe that the relative cost of cattle and steam draught has ever been regularly worked out, although it is a point on which there should be no mistake.

Mr. Chapman, in his Statement of the Present Cost of Carriage in Western India, as published in the papers illustrative of the prospects of the Great Indian Peninsula Railway Company, has taken the rates of conveyance of goods by carts travelling over roads, many of which are merely cleared tracks, scarcely any of which are bridged, and only one of which is both bridged and possesses a surface of *stone* metal, all the other so-called made roads being covered with a surface of moorum or indurated clay, the draft on which is double that of a good smooth surface stone-metalled road: in England it was reckoned that the tractive force of 21 cwt. on a broken stone surface was 56lbs., and on a *gravel* road 147lbs., and this is about the proportion on a moorum and stone-metalled road.

It would have been extraordinary, indeed, if all the science and skill employed on a steam-locomotive Railway could not compete with such a traffic as the above; but to have shown the true value of such a railway system, the comparison should have been made with the cost of carriage, only on good metalled and bridged roads, such as *ought* to exist all over the country, and such as might be constructed for a fraction of the cost of the proposed Railway. Now the rate of conveyance on the only real road, that from Poona to Panwell, as given in the tables, is 2·9 pence per ton per mile, whilst the rate of the rail is calculated at 2·75 pence per ton per mile; and 2·9 pence has to provide for the time the carts may not be employed, for the loss in returning empty, or for only half-fares, none of which drawbacks are supposed to attend the Railway, which is supposed to have unceasing employment throughout the year.

But what a system of cart-transit drawn by bullocks might be worked at, if conducted with the capital and regularity of a Railway, may be inferred from the following calculations of the *actual* cost of such transit, as compiled from the evi-

-ence of natives intimately acquainted with the subject, and which may be implicitly relied upon as the actual cost at which a native bullock-cart is worked in the Deccan.

Cost of Transit by Native Bullock-carts.

	Rupees.
A pair of common draught bullocks cost on an average 40 rupees, and will last 8 years, or a cost of 5 rupees a year, or per month	0·419
Food for one pair of bullocks per month	7·
Pay of driver, or value of driver's services per month	5·
Cost of a cart, 36 rupees, which will last ten years, or a cost of 3·6 rupees a year, or per month	·3
Tires for 2 wheels, cost 12 rupees, and will last 3 years, or 4 rupees a-year, or per month...	·33
Total cost of a bullock-cart per month	13·049
	12
Or for one year......................	156·588
Add 10 per cent. for sick bullocks, &c.....	15·63
	172·23 or £17 a-year

Such a pair of bullocks will draw an average load of 900lbs. (and this is a low estimate), and will travel eighteen miles a-day on a good, well-metalled bridged road (carts go from Poona to Ahmednuggur, seventy miles, in *three days*, and from Poona to Panwell, seventy-two miles in *three days*), or $\frac{900 \times 18 \times 300}{2240}$ lbs. $= 2170$ tons carried one mile at a cost of $172\frac{1}{4}$ rupees, or $344\frac{1}{2}$ shillings, or 4134 pence, or $\frac{4134}{2170} = 1·9$ pence per ton per mile, working 300 days in the year, and provided they travelled constantly with full loads, so that the Railway could not beat the present cart-traffic in cheapness, if the latter were conducted by a company.

But if we suppose a line of tram-rails or plate-rails to be laid down, and that such a line could be worked by bullocks travelling two miles and a half an hour, we shall find the advantage greatly in favour of the tram-line. It is acknowledged on all hands, that the tractive power required on an iron rail is only one-seventh that on a common road; and if the friction on a common road is taken at 65, as above, and that an iron rail at 9 or $\frac{1}{210}$th part of the road, it will give $\frac{65}{9} = 7$, as before; if, therefore, a pair of bullocks can draw 2170 tons one mile on a common road, they could draw

$2170 \times 7 = 15{,}190$ tons one mile on a tram-way, at the same cost of 4134 pence, or $\frac{4134}{15190} = \cdot 272$ of a penny per ton per mile, from which may be calculated the cost of making and working 100 miles of tram-road.

The highest rate that could be taken for a Tram- or Plate-Rail Cattle Railway in this country would be 2000*l.* per mile including terminus, buildings, and every expense; or, 100 miles at 2000*l.* a mile is 200,000*l.* Mr. Chapman calculates on 180,000 tons of goods to be carried every year by the Railway; but take only 100,000 tons of heavy goods, which we know to exist, then $100{,}000 \times 100 = 10{,}000{,}000$ tons carried one mile.

The Calculation then becomes,

	£.		£.
Annual cost of working the line at ·272 of a penny per mile for 10,000,000 tons carried one mile is	11,333	Revenue on 10,000,000 tons carried 100 miles at one penny per ton per mile.	41,666
Add 20 per cent. for establishment, porters, &c.	2,266		
Balance for dividend, at £14 per cent. on £200,000 cost of construction ..	28,067		
	£41,666		£41,666

Or, at *two pence* per mile, the dividend would be nearly 28 per cent.

For goods, then, for which a speed of two miles and a half an hour is sufficient, the cattle tram-line would yield the greatest return, as on 180,000 tons of goods the Bombay line is only estimated to pay 11 per cent, charging $2\frac{3}{4}$*d.* per mile.

For a traffic of 100,000 tons a-year, $333\frac{1}{2}$ tons must be carried every working day of 300 days in the year; and supposing the line to be worked twenty hours out of the twenty-four at two miles and a half per hour, goods would be conveyed the whole 100 miles in two days, or a little more allowing for stoppages and delay. It is proposed that the transit should be suspended during the four hours of extreme heat, or from eleven to three; but that the trains should pass all night; in fact the night, from its comparative coolness, would be the best time for such a transit, as by carrying good lights, and by means of bells or whistles, so as to give sufficient notice to

trains to turn into the sidings or passings, there need be no obstruction during the night. But with steam-locomotives the case would be very different; and it must be many years before they ever attempt to run steam-carriages by night in India, unless the most fearful accidents are to be considered no impediments.

In the foregoing calculations the Author is very confident as to the correctness of the actual cost of bullock-draught, but of the necessary allowance for establishment, he has no means of forming an accurate estimate; but allowing it to be fifty per cent. on the cost of carriage, the dividend would still be $12\frac{1}{4}$ per cent. at one penny per mile, or $24\frac{1}{2}$ per cent. at two pence per mile; or, admitting the cost of establishment to equal that of carriage, still a dividend of nineteen per cent. would remain at two pence per ton per mile, or $9\frac{1}{2}$ per cent. at one penny per mile. But the expense of establishment need be but very trifling, merely a set of porters and clerks, and a few managers, and people to be constantly on the line keeping it in repair when wanted, and thus guarding it from damage at the same time.

To carry $333\frac{1}{2}$ tons of goods a day throughout the line of 100 miles, about 750 pairs of bullocks would be required, as a pair of bullocks would draw $\frac{5017}{2240} = 2{\cdot}65$ tons eighteen miles a day, and for $333\frac{1}{3}$ tons $125{\cdot}7$ pairs of bullocks would be required, and for 100 miles $5{\cdot}5$ pairs, or $125{\cdot}7 \times 5{\cdot}5 = 691$ pairs of bullocks to keep the load constantly moving; and as ten per cent. has already been allowed for sick and lame cattle, &c., 750 pairs would appear ample, each pair going nine miles down the line, and nine miles up the line each day, or eighteen miles down one day, and eighteen miles up the next.

If the foregoing calculations have any semblance of correctness, the suggestion, put forth in the commencement of this Essay,—of the great Indian Peninsula Railway Company, taking in hand the small lines in Guzerat and other branch-lines for which cattle-draught is suitable—is believed worthy of the serious consideration of the Directors.*

* A pair of bullocks will draw, in a cart, 1,100lbs. of spirits or beer, over a good road, so that 900lbs is a very low estimate for a proper cart-load on such a road.

But however favourable the above statements may appear for the system of cattle-draught, the Author does not for a moment think it ought to shake faith in the desirableness of constructing comprehensive lines of Railway adapted to steam-locomotion, for reasons fully detailed in the text of this Essay; and to show that steam-locomotion has not more to compete with in India from cattle-draught, than it had in England, the following calculation of the cost of a Horse-tram or Edge Railroad, has been made, and which, it is believed, will be found sufficiently correct for our purpose.

Probable cost of Horse-draught in England.	£.
A cart-horse costs on an average 30*l*., and will last 8 years, or a cost per year..	$3\frac{3}{4}$
His food at 15*s*. per week, is per year......	39
Say one cartman to 4 horses in a waggon, at 30*l*. a-year, or for each horse ..	$7\frac{1}{2}$
Shoeing, &c., &c..	2
Wear and tear of harness for each horse.............................	$1\frac{1}{2}$
Taxes, &c., unknown, but say..	5
Cost of one horse per year...........	£$58\frac{3}{4}$

A cart-horse will in England draw one ton on a common turnpike-road, and travel for eight hours at a rate of two miles and a half an hour, or twenty miles per day, or 1 ton $\times$ 20 miles $\times$ 300 days $=$ 6000 tons moved one mile at an expense of 141,000*d*., or 2·35*d*. per ton per mile; or adding ten per cent for sick and lame horses $2\frac{1}{2}d$. per ton per mile, which is as near as possible the average rate at which goods are carried on the English Railways.

But were this calculation extended to a Tram-line drawn by horses in England, the same superiority in cheapness over the steam-locomotive power would be exemplified.

And yet notwithstanding this, 16,000,000 tons of goods are now carried by steam-locomotion in England; this probably is greatly owing to this fact, that steam-locomotion answers both for passengers and light goods, and parcels and perishable articles, as well as heavy goods; whereas the Tram-line is only available for heavy goods, and it would not answer to have both, therefore the Steam Railways have swallowed up all. Independent of which, the regularity and dispatch of the Railways have done a great deal, together with the monopoly of transit they possess by Act of Parliament, and the

absence of all competition on the *same lines*, which was the ruin of the coach system, which in itself *could* carry passengers as cheaply as can be done by rail, as the following calculation will show, the data of cost being taken from a work on Locomotion by Mr. Gordon, published in London in 1834, showing the actual annual expenditure on thirty-three coaches running between Manchester and Liverpool, and which, including every expense, duty, mileage, harness, tolls, ostlers, rent of stables, consumption of horses, hay and corn, amounted to 64,602*l.* a-year.

The number of horses kept up for these coaches was 709; each coach carried sixteen passengers, and was drawn by four horses (at least most of them were), and each horse is said to have travelled fifteen miles a day, drawing four persons, or $709 \times 4 \times 15 \times 365 = 15{,}529{,}100$ persons per mile, at an expenditure of 64,602*l* or 15,504,480*d*, $\frac{15504480}{15529100} = 1d.$ per mile per passenger, which is less than the average rate of one and a half passenger per mile, at which they are carried by the Railways; and yet the Railways have drawn the whole passenger traffic, in consequence of the speed at which they travel, and the regularity and precision of their movements, and the low fares as compared with what were charged by the coach-proprietors, and which became necessary, from the great competition on the same lines of roads, by which each coach only carried one-half or one-third its proper load.

There is no doubt that *time* is more valuable in England than it is in India, which is in favour of steam-locomotion; but the natives of India have never yet had an opportunity of testing the value of time; yet there is no reason to suppose that they will not duly appreciate its value when the wonderful advantages of a saving in time is practically brought before them by steam-locomotion; so that the decision of steam- or cattle-draught ought to rest upon whether the Railway is merely intended to carry heavy goods, and to pass near no large stations or towns, or whether it is to be made of general benefit to the community for the carriage of light, valuable, and also perishable articles, troops, passengers, letters, parcels, &c.; to be, in fact what an English Railway is, and to

be so lined out as to pass through as many large cities and stations as possible; for it cannot for a moment be supposed if the Railways are merely intended for the transit of heavy, bulky goods, that a Steam Locomotive Railway, charging $2\frac{3}{4}d.$ per ton per mile, could ever in India compete with an iron or plate rail-line worked by cattle, and carrying the same goods for one penny per ton per mile, at the rate of fifty miles a-day.

That the average load of 900lbs. for a cart used in the foregoing calculations is much below what a pair of bullocks are capable of drawing with ease on really good roads, is proved by an extract from a letter published in the "Bombay Times," of December 5, 1849, in which it is stated, that on the Grand Trunk road, between Allahabad and Cawnpore, a pair of bullocks draw a load of 2400lbs. in a cart, performing forty miles in twenty-four hours, travelling night and day, and each pair of bullocks only working twelve miles. Here each bullock draws 1200lbs. or more than half-a-ton on a common road.

The Palkee Ghrees, or Shigrams, travel at the rate of seven miles an hour on the same road, by which a passenger is conveyed at the charge of five annas per mile. These are the performances with which Mr. Chapman should have made his comparisons of Cattle and Steam Locomotion Traffic, and not with that of carts travelling over, in many instances, mere tracts, and unbridged and unmetalled roads, in which slopes of one in six are no uncommon occurrence.

Does not all this show that for more heavy-goods transit, Steam Railways are not wanted, and that such steam locomotion should only be put upon lines that will produce that universality of traffic, light and heavy, passengers, mails, &c., that the Malsej Ghaut line never can; but that the proposed Poona line will on its first opening.

From Malligaum to Bombay, by the Malsej Ghaut Rail line, will be thirty miles further from Bombay than by Nassick and Thul Ghaut. Suppose a tram-line, constructed from Malligaum to Bombay by the Thul Ghaut, a distance of about 183 miles, which at one penny per ton per mile, would

entail a cost of 183 pence, or 15*s.* 3*d.* per ton. By the Malsej Ghaut Rail line the distance is 213 miles, which at $2\frac{3}{4}d.$ per mile would amount to 49*s.* per ton, or more than three times the cost by the tram-line. Goods would reach Bombay in four days by the tram, and might accomplish the distance by rail in one day; but for heavy and bulky goods this would not compensate for paying three times the cost of transit, and as this Malsej line passes near no large town, or near no military cantonment, nothing but heavy goods would travel by it; the advantages of carrying a Steam Locomotive Railway by the Malsej Line may thus be inferred.

Allowing only 60,000 tons of goods to pass by the Thul Ghaut tram-road, which is only the quantity that has actually passed in the first year of the opening of this road, it would pay a dividend of 8 per cent. at a rate of one penny per ton per mile, and 16 per cent. at twopence per ton per mile, and on such a line as this there could be but little fear of any excess of construction or working. This calculation being made on an expenditure of 2000*l.* per mile, which is no doubt as much in excess, as the estimated traffic is below the probable reality.

C.

In an article on Railroads in the "Engineers' and Contractors' Pocket-Book for 1847-8," published by J. Weale, Holborn, a little unpretending work, containing a vast amount of information, particularly as a book of reference for those residing in India, or the Colonies, it is observed, that in estimating the cost of tunnelling, reference should be made to the expenditure per lineal yard of the various tunnels that have been completed, and the stratum through which work has been driven, from which by comparison the amount of cutting may be nearly ascertained, thus:—

Actual Cost of the principal Tunnels on the main English Lines.

	£.	s.	d.
South-Eastern Railway, Bletchingly tunnel, blue clay, shell, and sand-rock, per yard lineal	71	18	7
Salt Wood tunnel, middle beds of lower green sand ditto	118	0	0
Brighton-line, Merstham tunnel, chalk	63	0	0
Clayton-line, chalk and sandstone	51	0	0
Edinburgh and Dalkeith tunnel, clay	20	0	0
Leeds tunnel, shell, coal-measures, and rock	25	0	0
London and Birmingham, Kilsby tunnel	125	0	0
Newcastle and North-Shields	16	10	0
Midland railway, Roystone tunnel, red sandstone and lime	50	0	0
Claycross, on the same line, upwards of	100	0	0

The average of the above rates is 64*l.* per lineal yard for a double line, or 42*l.* per yard for a single line, supposing the latter to require a tunnel of two thirds the sectional area of the former. It can scarcely be expected that tunnelling through hard basaltic or trap-rock will be less expensive than the above average, especially in tunnels 1400 and 1600 yards long, through hills from 300 to 600 feet high, through which the sinking of the necessary numerous air-shafts alone will be a most expensive undertaking; and the *time* that the seven miles of tunnels on the Malsej line would take in execution would be a most serious cause of delay, as tunnelling is an operation that cannot be hurried on, especially where it must all be done by blasting.

The following is a list of the various tunnels required on the Malsej Ghaut line, between Bombay and the Pera river.

	Length of Tunnel. Yards.	Total Number.
Between Bombay and the foot of the Malsej Ghaut, or in a distance of 79 miles	1,427	1
	1,620	1
	333	1
	1,213	1
	207	1
	1,033	1
	167	1
	6,000	7
Up the Malsej Ghaut and to Koobee, or in a distance of about 7¾ miles	1,406	1
	1,886	6
	689	1
	3,981	8

	Length of Tunnel Yards.		Total Number.
Between Koobee and the Pera river, or in a distance of 54 miles	966	....	1
	1,500	....	1
	2,466		2
Or, in length of 140 miles of railway ......Total—	12,447	....	17
	Or, 7 miles.		

The above rates are *facts*, not *estimates*, and ought not to be disregarded.

D.

The calculation of 40,000 tons of traffic on the Bhore Ghaut, in 1848–9, has been made from the following statement of the number of each description of transit which passed up or down the Ghaut during that period.

Carts.	Bullocks.	Tattoos.	Camels.	
68,149	142,827	21,773	1,702	
Tons.	Tons.	Tons.	Tons.	
25,860	12,572	1,808	304	—Total, 40,544 tons.

The loads allowed have been as follows:—

Carts 850 lbs., bullocks 200 lbs., tattoos 186 lbs., camels 400 lbs. The load allowed for the carts is probably below the mark; and no notice is taken of carts with four bullocks, of which there were probably a considerable number, and which carry nearly double the load of a two-bullock cart.

In the Thul Ghaut the 50,000 tons of traffic in eight months and a half of 1849, was made up as follows:—

Opium.	Cotton.	Grain of Sorts.	Salt.	Miscellaneous.	Total Tons.
1,291	11,015	21,088	8,399	8,780	50,573

By one or other of these two Ghauts, every description of article is carried, containing every kind of European supplies and country produce, as may be seen by a list of the exports and imports between Bombay and the Concan, given in Mr. Chapman's papers, relative to the Bombay Railway.

E.

On October 19, 1849, the following were the prices of Cotton of different kinds in the Liverpool market:—

Sea Island $10\frac{1}{4}d.$ to $18d.$—Upland $5\frac{1}{8}d.$ to $6\frac{3}{4}d.$—New Orleans $5d.$ to $9d.$—Demarara $6\frac{1}{4}d.$—Egyptian $5\frac{1}{4}d.$ to $8d.$—Surat, &c. $3\frac{7}{8}d.$ to $5\frac{3}{4}d.$

Under the head of Surat, all cotton from India is included; the $5\frac{3}{4}d.$ per lb. being most probably the price of the Tinnevelly and Coimbatore cotton, previously described: so that although all cotton has fallen in value since 1835, the average proportion of prices continue much the same, especially as regards Surat cotton.

F.

It would appear by an article in the "Bombay Times" of the 8th December, 1849, that electric communication can be carried across a space of water, without the necessity of laying a continuous wire from shore to shore; or, in fact, that an electric telegraph in the fort of Bombay could be made to communicate direct with Inora Bunder, and so onward, without laying wires across the harbour, so that this objection to the Inora Bunder line not only vanishes, but would require a less length of wire than if sent round by Tanna.

DESCRIPTION OF THE PLATES.

Plate I.

Is a map of the greater portion of the Bombay Presidency, showing the general extent of Guzerat Cotton districts at the head of the Gulf of Cambay, as marked by a strong dotted line, by which its total exclusion from any benefits from the proposed Bombay Railway will be seen.

The proposed tram-line for cattle-draught from Baroda to Tankaria Bunder, is marked, and also the direct route from Baroda to Oojein and Maliva, by which the Opium passes, and by which, when this tram-line is completed, a considerable traffic will probably be drawn from Maliva and Meywar, &c.

The road by the Thul Ghaut to Nassick and Candeish, is marked, as also the proposed line of Railway from Bombay by the Malsej Ghaut, and the line now proposed by the Author of this Essay, by Poona and Aurungabad to Boorhanpoor.

The position of Oomrawutty, which is on the borders of Berar, and from whence the Berar Cotton is brought, is shown.

The position of Inora Bunder, on the Island of Carranja, near Bombay, will be seen on the map, and the direction of the proposed new line from thence to Poona, by Captain W. D. Graham, of the Engineers, is marked.

Plate II.

Fig. 1—Is an elevation of one span of the proposed timber and wrought-iron Viaduct.

Fig. 2.—A section through the centre of the same ; the dotted lines show the section through one of the piers, with the struts for the railing and for the cast-iron saddles, which are drawn in dotted lines.

Figs. 3, 4, 5, 6—Are several parts of the viaduct on a larger scale. Fig. 5, the top rail and posts, and Fig. 6 a section of the same, showing the manner in which it is proposed to tighten up the diagonal ties. Fig. 3 shows the bottom rail-post, cross-girders, and struts, with the manner of fixing the diagonals, and also the main-chains and stirrup. Fig. 4 is the centre of the top rail.

Fig. 7—Is a section of the rails, longitudinal sleeper, and cross-girders, on a larg[e] scale. The part marked W, under the bottom of the rail, may be filled in with har[d] wood, so as to simplify the fitting of the rail on to the sleeper, and at the same time t[o] secure a bearing ; the rail is drawn to the present approved of "cant."

LONDON:
Printed by S. & J. BENTLEY and HENRY FLEY,
Bangor House, Shoe Lane.